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TREATMENT OF BENIGN GIANT-CELL TUMORS *

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To the orthopaedic surgeon it is obvious that there exists a considerable difference of opinion among those who have had the opportunity to gain experience in the treatment of bone tumors in medical centers where clinician, roentgenologist, pathologist, and surgeon cooperate in their efforts to produce better results. The scientific evaluation of any treatment demands correct diagnosis, skill, and judgment in the selection and management of the method employed and a careful follow-up record over a period of years. Too often a method has become discredited because it was assumed to have been the procedure of choice when, in reality, the diagnosis was based on insufficient evidence and the subsequent course proved the error.

There is opportunity for the display of considerable judgment in the selection of the most efficient method to be employed in the treatment of benign and malignant bone tumors, especially of the rarely encountered giant-cell tumors which at times present such a clinical enigma that they challenge the physician's ability to cope with them. The site and the size of the tumor, the perforation or the non-perforation of the bony shell, the penetration of the soft tissues, and the rapidity of growth are important factors in determining the method of treatment to be employed.

As giant-cell tumors were formerly considered to be malignant and were classified with sarcomata of bone, the treatment was radical and amputation was commonly practised. As knowledge of the pathology of bone advanced, the benign nature of such giant-cell tumors was recognized and treatment became less radical, the accepted method of treatment being curettage followed by chemical or thermal cauterization. Some of these tumors were found to recur and repeated surgical treatment was necessary before cure was effected; others were found to metastasize.

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 21, 1936.

The supposed transition from benignancy to malignancy was ascribed to meddlesome surgery. There then arose a group of roentgenologists who advocated irradiation to the exclusion of all other forms of treatment, and some convincing cases of apparent cure were reported after surgical treatment of various types had failed. Other roentgenologists reported failures from the use of irradiation. Therefore, both successes and failures were attributed to surgery and to irradiation individually, and accordingly combinations of both methods were employed. The results improved, but unfortunately in some instances either form of treatment or a combination of both resulted in sufficient damage to the tissues to make amputation inevitable. Too often a good surgeon is led astray by the incorrect interpretation of roentgenograms or microscopic sections.

The author prefers to use the terms "benign giant-cell tumors" and "malignant giant-cell sarcomata", and this paper will be confined to the former group. Pathologists have been able to differentiate these two variants and the writer believes they should both be included in the classification of the Registry of Bone Sarcoma. However, it appears impossible at present to differentiate microscopically giant-cell-tumor tissue found in cases of osteitis fibrosa cystica from the generalized skeletal lesions found in cases of parathyroid tumor with hyperparathyroidism. Values for calcium greater than twelve milligrams, for phosphorus less than three milligrams, and for phosphatase greater than five units per 100 cubic centimeters of blood are important factors in the differential diagnosis. Although there may be a relationship between such lesions and benign giant-cell tumor, they have been excluded from the present investigation. To the practical surgeon this differentiation is important, for delay is dangerous. Since he cannot differentiate the benign and the malignant forms, he obtains consent for the type of operation which in his judgment is indicated as the best way of eradicating the tumor. The surgical pathologist, however, may often be of great aid in determining whether the growth is benign or malignant before the operation is completed. Were it possible to give every patient who complains of swelling or pain the benefit of early and expert service of a roentgenologist, the presence of tumors would be discovered in time to make treatment more efficient and the prognosis better. Surgeons are too often consulted only after the destructive changes have become so extensive that surgical intervention of a conservative type is of questionable value. The conscientious surgeon realizes that biopsy is justified only in cases of tumor of an unusual clinical and roentgenographic character and that most tumors may be diagnosed roentgenographically. He also appreciates the fact that certain kinds of tumor respond to such an extent as to make diagnostic irradiation possible and that no one treatment is infallible. Accordingly he confers with his associates so that he may give the patient the most efficient care.

Simmons observed that 7.5 per cent. of giant-cell tumors which had been treated conservatively were later found to be malignant and to have

TABLE I

SEX AND AGE INCIDENCE

Sex	No. of Patients	Per Cent.
Males	26	42.6
Females	35	57.4
Total	61	100.0

Age	Youngest (*Years*)	Oldest (*Years*)	Average (*Years*)
Males	12	60	27.9
Females	13	48	27.9

Age by Decades	Males	Females	Total	Per Cent.
10 to 19	9	7	16	26.2
20 to 29	6	15	21	34.4
30 to 39	7	7	14	23.0
40 to 49	1	6	7	11.5
50 to 59	2	0	2	3.3
60 to 64	1	0	1	1.6
Total	26	35	61	100.0

produced pulmonary metastasis. Coley reported fifty cases in which giant-cell tumors were diagnosed as benign, but in which ten patients died of metastasis. MacGuire and McWhorter reported twenty cases, in four of which the tumors proved to be malignant later on. Finch and Gleave, Chatterton and Flagstad, and Sosman, Dyke, and Orr have referred to similar cases. In the present series of cases one (1.5 per cent.) of the patients was later found to have microscopic evidence of osteogenic sarcoma, but the pathologist checked the slides and verified the original diagnosis of benign giant-cell tumor. Coley obtained varied diagnoses in submitting the same tissue to different pathologists, and, although he was of the opinion that the majority of giant-cell tumors could be diagnosed by clinical and roentgenographic examination, 20 per cent. required microscopic interpretation. Bloodgood, out of a total of 177 cases collected from the Registry of Bone Sarcoma together with some of his own, found no evidence of metastasis of giant-cell tumors. Both Simmons and Kolodny, after reviewing cases in the Registry of Bone Sarcoma, reported similar findings.

Primary irradiation of tumors based on the clinical and roentgenographic findings alone is more likely to lead to error than when microscopic examination by an experienced pathologist is made. The author

TABLE II

Distribution of Tumors

Situation of Tumor	Males	Females	Total	Per Cent.
Femur	9	12	21	34.4
Tibia	4	8	12	19.8
Humerus	4	1	5	8.2
Ulna	2	3	5	8.2
Ilium	3	1	4	6.6
Radius	1	2	3	4.9
Fibula	2	0	2	3.3
Lumbar vertebra	1	1	2	3.3
Pubic bone	0	2	2	3.3
Scapula	0	1	1	1.6
Foot	0	1	1	1.6
Cervical vertebra	0	1	1	1.6
Sacrum	0	1	1	1.6
Eighth rib	0	1	1	1.6
Total	26	35	61	100.0

does not believe in routine irradiation of all bone tumors, nor does he consider it advisable as a primary or sole method of treating the giant-cell group of tumors. He feels that irradiation treatment takes too long and causes loss of valuable time in which metastasis may occur, and that the patient may lose the opportunity of cure by more radical measures. Too often benign and malignant tumors are treated without differentiation. Both soft and osseous tissues may be damaged, radiodermatitis and ulceration may occur, and, should operation be indicated, the tissue may break down, resulting in interference with conservative surgery.

However, at times irradiation is the only treatment possible, and the writer has seen large inoperable tumors of the pelvis slowly regress and ultimately be apparently cured under its influence; it is with this type and with vertebral tumors and following operations that irradiation is usually employed. In the ten years preceding 1926, irradiation was employed at the Clinic in eight cases,—in three, following biopsy; in four, in combination with curettage; and in one, following amputation. In the ten-year period following 1926, irradiation was used at the Clinic in twenty-two

TABLE III

Clinical Findings on Admission

	Males	Females	Total	Per Cent.
History of trauma	11	15	26	42.6
Limitation of motion	13	21	34	55.7
No previous treatment or operation	17	14	31	50.8
Previous treatment or operation	9	21	30	49.2

TABLE IV

DURATION OF DISEASE

DURATION OF SYMPTOMS PRIOR TO OPERATION AT THE CLINIC

Duration (Years)	Patients	Per Cent.
0 to 1	28	46.0
1 to 2	17	27.9
2 to 3	5	8.2
3 to 4	4	6.6
4 to 5	1	1.6
6 to 7	3	4.9
8 to 9	1	1.6
10	1	1.6
Not stated	1	1.6
Total	61	100.0

Average: 1.6 years

POSTOPERATIVE LENGTH OF LIFE

(All living except one *)

Duration (Years)	Patients	Per Cent.
0 to 2	5	8.2
3 to 4	7	11.5
5 to 9	25	41.0
10 to 14	15	24.6
15 to 19	9	14.7
Total	61	100.0

Average: 7.9 years

TOTAL DURATION OF DISEASE

Duration (Years)	Patients	Per Cent.
0 to 3	3	4.9
3 to 4	4	6.6
5 to 9	26	42.6
10 to 14	16	26.2
15 to 19	8	13.1
20 to 22	4	6.6
Total	61	100.0

Average: 10.3 years

* Died of embolism following prostatic operation elsewhere.

TABLE V

SUMMARY OF TREATMENT AND POSTOPERATIVE DURATION OF LIFE

Treatment at the Clinic	Patients	Per Cent.	Postoperative Duration of Life (Years)				
			0 to 2	3 to 4	5 to 9	10 to 14	15 to 19
Biopsy and irradiation	7	11.5	2	1	2	1	1
Curettage alone	11	18.0	0	2	3	5	1
Curettage and irradiation	13	21.3	1	1	7	4	0
Curettage and bone graft	10	16.4	1	1	7	0	1
Curettage, bone graft, and irradiation	4	6.6	1	0	1	1	1
Resection (in 2 cases plus irradiation)	3	4.9	0	1	0	2	0
Amputation	13	21.3	0	1	5	2	5
Total	61*	100.0	5	7	25	15	9
Per Cent.			8.2	11.5	41.0	24.6	14.7

* All living except one who died 10 years later of embolism following prostatic operation.

cases,—in four, after biopsy; and in eighteen, in combination with curettage, resection, bone graft, or amputation.

In an attempt to arrive at some conclusions of value, the case histories, clinical findings, laboratory findings, roentgenograms, and microscopic findings have been studied in sixty-one cases of giant-cell tumor in which patients have been operated on at the Clinic in the twenty-year period from 1916 to 1936. Cases of epulis of the jaw were excluded from consideration.

Twenty-six of the patients were males and thirty-five were females; the average age of each being twenty-seven and nine-tenths years (Table I). The situations of the tumors in these sixty-one cases are given in Table II and data relative to a history of the trauma, limitation of motion, and prior treatment are shown in Table III.

The duration of symptoms prior to operation at the Clinic, the postoperative length of life, and the total duration of the disease are given in Table IV.

BIOPSY AND IRRADIATION

Of these sixty-one patients, seven were treated by irradiation following biopsy on their admission to the Clinic (Tables V and VI). Three of these seven had had no previous treatment and were living eleven and a half years, three years, and eight months respectively, or an average of five and eight-hundredths years, following irradiation at the Clinic (Table VII). One of these three patients underwent amputation elsewhere three months after having taken a course of irradiation at the Clinic and after having been advised that there would be a temporary reaction with an increase in

size of the tumor. The other two of these three patients were apparently well at the time when this report was written and have had no further treatment. Four of the seven patients had received irradiation or treatment by manipulation or casts before coming to the Clinic, and they were living fifteen, seven and a half, five, and two and a half years respectively, following irradiation at the Clinic. Of these four patients, two are well; one has had repeated irradiations; and the other has had a bone-graft operation and treatment by irradiation. The average period of survival for these four patients following irradiation is six and forty-six hundredths years.

Biopsy was performed in 11.5 per cent. of the cases. It is a useful procedure in certain cases of tumor in which the diagnosis is difficult to

TABLE VI

SUMMARY OF TREATMENT AT CLINIC ACCORDING TO YEAR GIVEN

Year	Patients	Per Cent.	Biopsy and Irradiation	Curettage Alone	Curettage and Irradiation	Curettage and Bone Graft	Curettage, Bone Graft, Irradiation	Resection	Amputation
1916	3	4.9		1			1 R		1
1917	1	1.6							1
1918	2	3.3		1					1
1919	3	4.9							3
1920	5	8.2	2 R*			1			2 (1X)
			R and X†						
1921	4	6.6	1 X	1	2 R				
					R and X				
1922	3	4.9		2				1	
1923	0								
1924	1	1.6						1 R and X	
1925	2	3.3		2					
1926	6	9.8		1	3 X		1 X		1 X
1927	4	6.6			2 R and X	2			
1928	3	4.9	1 X			1	1 X		
1929	5	8.2			4 X	1			
1930	6	9.8		1		3			2
1931	6	9.8	1 X	2		1		1 X	1 X
1932	3	4.9	1 X		1 X				1 X
1933	1	1.6	1 X						
1934	2	3.3			1 X		1 X		
1935	1	1.6				1			
Total	61		7	11	13	10	4	3	13
Per Cent.			11.5	18.0	21.3	16.4	6.6	4.9	21.3

* R = radium.

† X = roentgen rays.

make from the clinical and roentgenographic findings. In the hands of an experienced surgeon little harm results, and, if the location of the growth is such that it makes it inadvisable to explore and to obtain a section of tissue of any size, then an aspiration needle is inserted and bits of tissue can be obtained for microscopic examination. Since serious hemorrhage may be encountered or infection may follow, which in some instances may result in disaster, the surgeon must be prepared to approach biopsy with the same degree of preparedness as if he were to do an extensive operation.

CURETTAGE

Eleven patients were treated by curettage alone or by curettage and cautery (Tables V and VI). Six of these patients had had no previous treatment and all were living and well seventeen, fourteen, thirteen and one-half (two patients), eleven, and six years later, or an average of twelve and five-tenths years, following curettage at the Clinic (Table VII). One of the six had a second curettage. The remaining five patients in the group had had some form of treatment before admission. One had been treated by means of curettage, cautery, and casts and had received considerable irradiation; this patient had a very offensive odor and was found to be suffering from a large cavity in the lower portion of the femur and from radiodermatitis, ulceration, osteomyelitis, and ankylosis of the knee joint. Treatment by curettage and the application of Dakin's solution proved of benefit, but four and a half years later the cavity, open wound, and damaged skin persisted. Another of the five patients had had curettage and radium treatment, but a sinus formed and, eleven years after treatment at the Clinic, he sustained a fracture, for which he was treated elsewhere. The third patient had previously been treated by manipulation and irradiation and was well nine years after curettage at the Clinic; the fourth had had treatment by irradiation previously and was well seven and a half years after curettage at the Clinic; and the remaining one had had curettage and treatment by a cast previously and was well four and a half years following curettage at the Clinic. These five have lived an average of seven and thirty-two hundredths years since curettage at the Clinic.

Thus, of the eleven patients in this group who were treated at the Clinic by curettage alone or by curettage and cautery, all are living at an average of nine and nine-tenths years following such treatment, and the results appear favorable in 81.8 per cent. of the cases. Two patients were admitted in such a condition as to make favorable prognosis practically impossible.

Bloodgood reported 80 per cent. cures by curettage and cautery. Simmons reported 62 per cent. cures from a review of the material in the Registry of Bone Sarcoma. In order to be successful, curettage must be employed for tumors which permit of complete removal, and a dry field is imperative; the mere stirring up of the tumor by the curette is both useless and dangerous, and causes the operation to fall into disrepute. Cautery

by thermal or chemical means aids in destruction of the tumor. The operation should be done under the tourniquet, and all loose particles should be washed from the wound. Packing may be necessary, but whenever possible the author prefers immediate closure of the wound layer by layer and the application of bandages and splints to obtain complete rest of the parts involved.

CURETTAGE AND IRRADIATION

Thirteen patients (21.3 per cent.) were treated by curettage and irradiation (Tables V and VI). Eight patients had had no previous treatment (Table VII), and of these two were living ten years, two * eight years, one seven years, and three six years following curettage and irradiation at the Clinic, or an average of seven and nine-tenths years. One died of embolism elsewhere, following a prostatic operation ten years after his dismissal from the Clinic. Five patients had had treatment before coming to the Clinic. One had previously had a tumor "removed" and was living ten years after treatment at the Clinic; this patient later sustained a fracture and joint damage that made walking and labor difficult. One had had a cast applied previously and was well ten years following treatment by curettage and irradiation at the Clinic. One had previously been treated by irradiation, with both roentgen rays and radium, and was living six and a half years after treatment at the Clinic, although two curettages and two courses of irradiation were necessary to obtain a cure. One had had treatment for fracture before coming to the Clinic and is still under treatment elsewhere, having had several curettages and bone grafts; non-union is still present, however, three and a half years following these procedures. One (Case 6) had previously been treated by "incision" and was cured by curettage and irradiation in fourteen months.

Thus, of the thirteen patients in this group who were treated by curettage and irradiation at the Clinic, eleven may be said to have remained well, making 84.6 per cent. "cures". One died ten years later of a cause not associated with tumor, and two have huge tumors of the lower portion of the femur and persisting disability which may bring them to amputation. Simmons reported 72 per cent. cures from curettage and irradiation in the Registry of Bone Sarcoma.

CURETTAGE AND BONE GRAFT

Ten patients, or 16.4 per cent., were treated by curettage and bone graft (Tables V and VI). Four of this group had had no previous treatment and were living and well fifteen and a half, eight and three-fourths, four and a half, and three-fourths years, or an average of seven and three-tenths years, following curettage and bone graft at the Clinic (Table VII). Six had had treatment before admission. Two of these had previously been treated by irradiation,—one (Case 3) is cured six and three-fourths years and one has slight disability but no recurrence seven and one-fourth

* The case of one of these patients (Case 9) is reported later.

TABLE VII

POSTOPERATIVE LENGTH OF LIFE ACCORDING TO TYPE OF TREATMENT AT CLINIC *

Type	Primary Treatment at Clinic	Primary Treatment Elsewhere	Total Patients	Postoperative Length of Life (Years)																	
				0 to 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19
Biopsy and irradiation	3	4	7	1†		1	1		1		1				1				1			
Curettage alone	6	5	11					2		1	1		1		2		2	1			1	
Curettage and irradiation	8	5	13		1		1			4	1	2		4								
Curettage and bone graft	4	6	10	1‡				1	2	2	1	2							1			
Curettage, bone graft, and irradiation	1	3	4		1						1			1								1
Resection	1	2	3				1								1		1					
Amputation	8	5	13				1		3	1			1	1			1			2	2	1
Total	31	30	61	2	2	1	4	3	6	8	5	4	2	6	4		4	1	2	2	3	2
				5			7			25				15					9			
Per cent.	51	49	100	8.2			11.5			41.0				24.6					14.7			

* All patients living except one who died ten years postoperatively of an embolism following a prostatic operation.

† Eight months.

‡ Nine months.

years following curettage and bone graft at the Clinic. One (Case 5) had previously undergone "excision and bone graft" and is well five and three-fourths years; one had been treated by aspiration and is well five years; and two had had some form of splint treatment and are living and well eight and three-fourths years (Case 2) and six years (Case 7) following curettage and bone graft at the Clinic, or an average of seven and nine-tenths years.

Thus, although three patients did have in addition some irradiation, the results for this group of patients treated by curettage and bone graft were 100 per cent. good. The operation entails considerable judgment in the selection of cases and requires the strictest asepsis and orthopaedic skill.

CURETTAGE, BONE GRAFT, AND IRRADIATION

Four patients (6.6 per cent.) were treated at the Clinic by curettage, bone chips, or grafts and irradiation (Tables V and VI) and these are living on an average of nine and twelve-hundredths years later (Table VII). One of these patients had previously been subjected to biopsy and had had

two courses of irradiation. This patient had lost forty-four pounds (twenty kilograms) and was considered to have a malignant tumor, yet is living seventeen months after operation with apparently no evidence of recurrence and is in excellent health. A second patient (Case 4) had been treated for tuberculosis and had secondary anaemia, but is living more than seven years after operation; there is no evidence of recurrence, although the patient limps and has soreness about the hip. The third patient had had six irradiation treatments and curettage prior to admission to the Clinic and received at the Clinic treatment by roentgen rays, radium, curettage, and bone insert over a period of two years. This patient has a residual deformity, but no recurrence nineteen years following treatment at the Clinic. The fourth patient in the group had had no previous treatment and is well and has good function ten years following operation at the Clinic.

The insertion of bone chips into large cavities following curettage aids in filling the defect and stimulates the formation of bone, external fixation often being necessary following operation in cases in which tumors are large. The implanting of radium into cavities is seldom practised because of the increased risk of infection. Excessive irradiation preoperatively or postoperatively prevents repair of bone and, when accom-

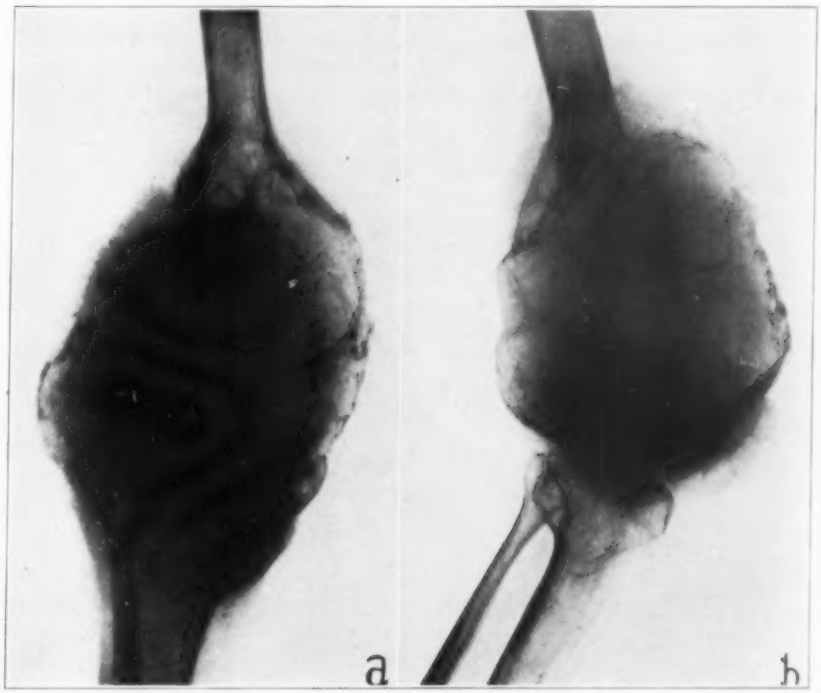

FIG. 1

Anteroposterior and lateral views, showing huge giant-cell tumor of the lower end of the left femur.

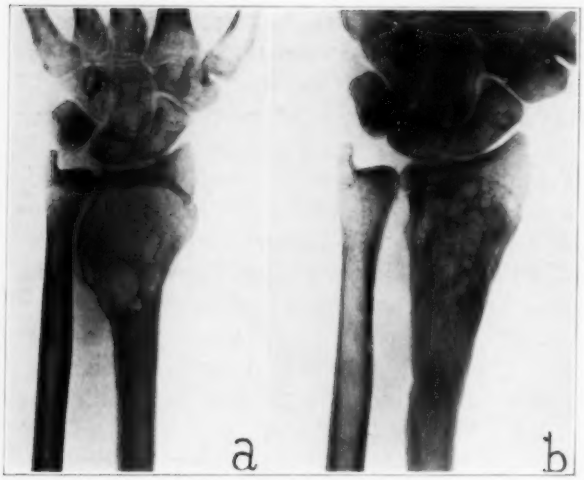

FIG. 2

Giant-cell tumor of the distal end of the radius.
a: Before operation.
b: Nine months after curettage and autogenous bone graft.

panied by the added trauma of surgery, may lead to ulceration and to loss of the grafts.

RESECTION

Three patients (4.9 per cent.) were treated by excision, and are living on an average of nine years later (Tables V, VI, and VII). One had had no previous treatment and is living three years later; one had had neurectomy for pain and is well thirteen and a half years later; and one had undergone an exploratory operation, a diagnosis of sarcoma having been made, and is well eleven and three-fourths years following resection at the Clinic.

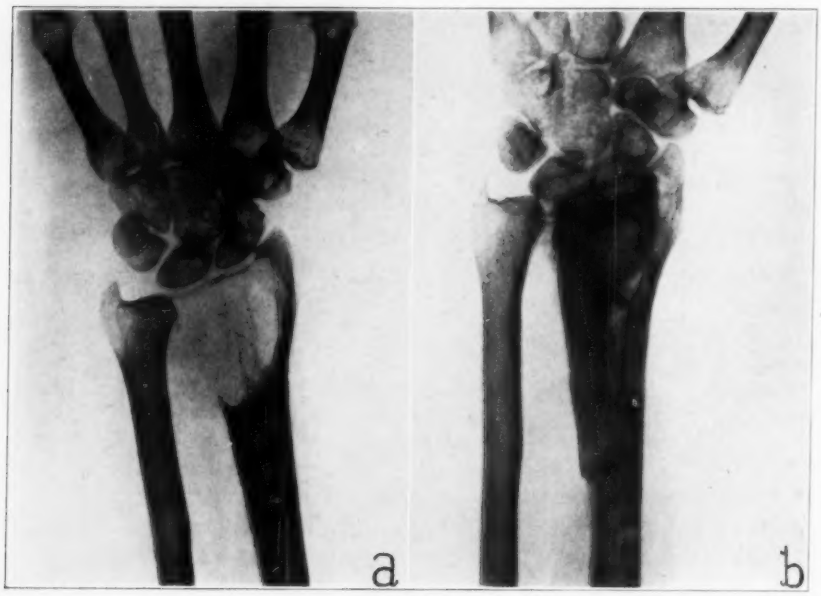

FIG. 3

Giant-cell tumor of the distal end of the left radius.
a: Before operation.
b: Six years after removal by curettage and autogenous bone graft.

The author agrees with Simmons that this is the operation of choice when feasible; its application, however, is limited usually to such bones as the radius, the ulna, the ribs, the head of the femur, and the fibula. Simmons reported 100 per cent. good results from the Registry of Bone Sarcoma.

AMPUTATION

Thirteen patients (21.3 per cent.) were treated by amputation and all are living on an average of nine and sixty-eight hundredths years later (Tables V, VI, and VII). Eight had had no previous treatment at the Clinic. One had had curettage and cautery at the Clinic two years prior to amputation and is living and well nineteen years later. One had curettage and cautery nine months prior to amputation and is living sixteen years later. One patient (Case 8) had been advised to undergo amputation but instead had had treatment consisting of curettage and cautery, finally coming to amputation six years later; this patient is living and well eleven years following amputation. One had received treatment by curettage, cautery, and irradiation three and a half years prior to amputation, a sinus persisting. The pathologist reported osteogenic sarcoma but, on review, corroborated the original diagnosis of benign giant-cell tumor; however, this diagnosis has not as yet been accepted as final and the tissue is being submitted to further study. This patient is living two and a half months following amputation. Two patients are living sixteen and eleven years, respectively, following amputation, and two, who had postoperative irradiation, are living six (Case 1) and five years, respectively, following amputation, or on an average for the eight patients of ten and seven-tenths years.

Five patients had had treatment before consultation. Three had had manipulations for injuries and were living thirteen and a half, nine and a half, and five and a half years following amputation at the Clinic. One had undergone exploratory operation and was living five and a fourth years later, and one was treated for syphilis and was living seventeen and three-fourths years following amputation. The average postoperative length of life for the five patients in the group, therefore, was eight years.

Amputation may be the only recourse in some cases of

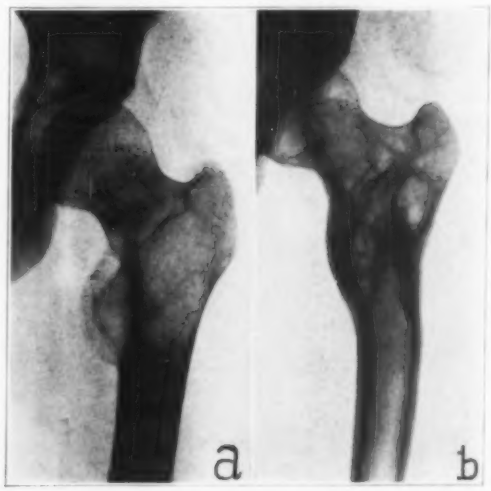

FIG. 4

Giant-cell tumor of the upper end of the left femur.
a: Before operation.
b: Two years after curettage and crushing in of the cortex.

extensive involvement, especially of the knee joint, or following excessive irradiation with the development of ulceration and infection. For older patients, when the function of the lower extremity is seriously impaired and life would be endangered by attempts to save the extremity, amputation is preferable. At the Clinic amputation has been used less with added experience and earlier diagnosis, eight amputations having been performed in the five-year period from 1916 to 1921, but only five having been performed during the fifteen-year period from 1921 to 1936. Our studies indicate that at least in some instances amputation could have been avoided had early and conservative measures been employed. No doubt, in the future the more common use of roentgenographic examination for painful lesions of bone will bring patients to the orthopaedic surgeon at a time more favorable for treatment.

ILLUSTRATIVE CASES

CASE 1. A girl student, twenty-two years of age, came to the Clinic on June 23, 1930, because of swelling, pain, and a tumor above the left knee. She recalled having injured this knee several times about three years previously, and approximately six months later pain in the knee had developed. An orthopaedic surgeon had thought that the condition was malignant and had advised amputation.

Examination at the Clinic disclosed a huge mass, palpable in the lower end of the femur, and a clinical and roentgenographic diagnosis of giant-cell tumor was made (Fig. 1). The blood count was normal; the urinalysis was negative; and the Wassermann test was negative. Roentgenograms of the thorax were also negative.

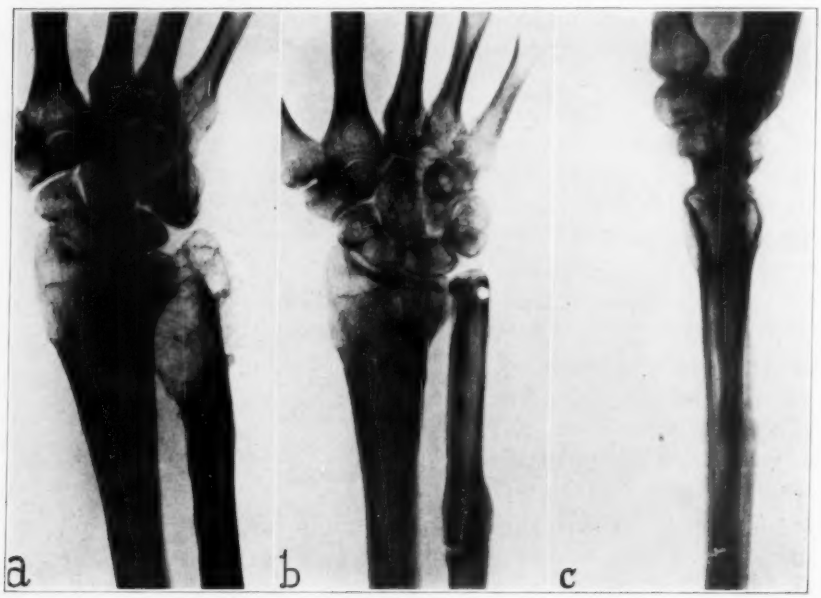

FIG. 5

Recurrent benign giant-cell tumor of the right ulna.
a: Anteroposterior view, before operation.
b and *c:* Anteroposterior and lateral views, nine months after resection of the tumor and application of an autogenous bone graft taken from the fibula.

Because of the extensiveness of the tumor it was thought inadvisable to carry out conservative measures and, on June 26, 1930, amputation was performed. No other treatment was given and the patient was dismissed from the hospital on the thirteenth postoperative day.

In a letter received in March 1931, she stated that she had gained about fifty pounds (twenty-two and seven-tenths kilograms) and was in excellent condition. In January 1936, she again reported that she was well and that further treatment had not been necessary.

FIG. 6

Giant-cell tumor of the proximal portion of the left ulna.
a: Before operation.
b: Nine months following excision and cautery.

CASE 2. A youth, aged eighteen years, came to the Clinic on May 28, 1927, because of a growth in the lower portion of the left radius of three months' duration. Two weeks prior to the onset of swelling he had sustained several injuries in the region of the right wrist. Roentgenograms had been taken and a splint had been applied for giant-cell tumor.

On examination at the Clinic the patient appeared to be in good condition and had not lost weight. Urinalysis was negative and the blood count was within normal limits. A roentgenographic diagnosis of giant-cell tumor was made (Fig. 2, *a*).

At operation on May 31, 1927, the tumor was removed and a bone graft, which had been taken from the right tibia, was inserted. This

FIG. 7-A

FIG. 7-B

Giant-cell tumor of the left humerus with a pathological fracture.
Fig. 7-A: Before operation.
Fig. 7-B: Nine months after curettage and application of an autogenous bone graft.

FIG. 8

Giant-cell tumor of the lower end of the right femur with involvement of the knee joint.

was forced into the medullary cavity and against the remaining epiphysis, after which multiple bone chips were packed about the area to aid in the formation of bone. The pathologist reported "foreign-body giant-cell tumor". No subsequent treatment was given. Convalescence was uneventful and the patient left the hospital at the end of the fifth week.

In a letter received in January 1936, the patient said that he was well and that he had had no further treatment nor any recurrence of the tumor; he also said that his arm was "just as strong as it was before the injury".

CASE 3. A housewife, aged thirty-eight years, came for examination on April 8, 1929, complaining of pain, limitation of motion, and partial disability of the left wrist of nine months' duration. She had injured this wrist five months previously and, over a period of about five weeks prior to her admission, she had noticed the formation of a tumor. She had been given two roentgen treatments prior to admission.

Examination at the Clinic revealed swelling, tenderness, and limitation of motion of the left wrist. There had been no loss of weight. The Wassermann test was negative; the blood count was normal; and urinalysis was negative. A clinical and roentgenographic diagnosis of giant-cell tumor of the lower left radius was made (Fig. 3, *a*).

At operation on April 11, 1929, under tourniquet, the entire tumor was removed with a curette, and an autogenous bone graft was inserted. Subsequent treatment by roentgen rays, radium, or toxins was not given. The patient was dismissed from the hospital twenty-four days following admission. At that time she was wearing a plaster cast.

In a letter received in January 1936, about seven years later, she said that she had had no further treatment and no further recurrence, and that she was "greatly pleased" with the result of the operation and had "good function".

CASE 4. A girl student, aged eighteen years, came to the Clinic on February 27, 1928, because of pain in the upper portion of the left femur. She stated that this pain had been present for the previous six months and had caused her to limp. There was no history of injury. A diagnosis of tuberculosis had been made and a plaster cast had been applied; she had worn the cast for a couple of months.

On examination at the Clinic the Wassermann test and urinalysis were found to be negative. The tonsils had been removed previously; roentgenograms of the thorax were negative. Roentgenograms of the left femur were diagnosed by the roentgenologist as showing giant-cell tumor of the upper part of the left femur (Fig. 4, *a*). The patient had secondary anaemia and had lost about fourteen pounds (six and four-tenths kilograms).

On March 1, 1928, the patient was operated on. The tumor was thoroughly removed with a curette and the cortex was crushed in. The wound was closed without drainage and a spica cast was applied. The pathologist reported giant-cell tumor. No subsequent treatment was given and the patient was dismissed with a walking caliper splint.

The patient was seen about twenty months later, in January 1930, and, because of possible recurrence of the tumor, she was operated on again on January 23.

The tissue removed was reported negative by the pathologist, there being no evidence of tumor. Two courses of irradiation, each over three areas, were given,—the first on February 10, 1930, and the second on March 17, 1930. The following technique was used: The roentgen rays were generated at 135 peak kilovolts, filtered through six millimeters of aluminum at a distance of sixteen inches (forty and six-tenths centimeters), with five milliamperes of current, and were applied for twenty-five minutes the first time and twenty-two minutes the second time. The patient was living and well eight years after the original operation.

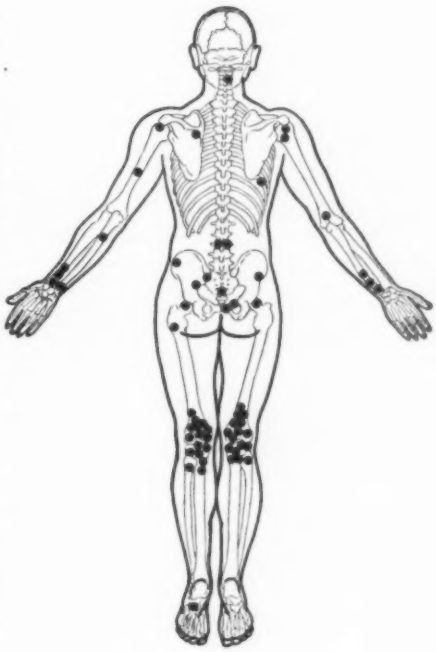

FIG. 9

Showing various situations of giant-cell tumors.

CASE 5. A shoemaker, thirty years of age, came to the Clinic on May 5, 1930, complaining of pain in the lower right forearm and of the formation of a tumor. This condition had been present for about two and a half years. He had been treated by his local physician for rheumatism. Six months after the onset of the condition he had consulted a surgeon, and a tumor of the right ulna had been excised and a bone graft had been inserted. There had been recurrence of pain and swelling.

Roentgenographic examination at the Clinic revealed giant-cell tumor of the lower end of the right ulna (Fig. 5, *a*). Roentgenograms of the thorax were negative.

The patient was operated on May 9, 1930. The entire lower third of the right ulna was excised and about four and one-half inches (eleven and four-tenths centimeters) of the left fibula was resected, inserted in the area, and held with beef-bone screws. A cast was then applied. The pathologist reported foreign-body giant-cell tumor. No subsequent roentgen therapy nor toxin treatment was given.

The patient was well and had obtained a good functional result when last heard from, nearly six years following operation.

CASE 6. A stenographer, aged twenty-eight years, reported for examination on December 5, 1934, because of pain in the left forearm of about a year's duration. Her general health had been good. Two incisions had been made in the forearm, but a definite diagnosis had not been given.

On examination at the Clinic urinalysis was negative and the blood count was normal; roentgenograms of the thorax were also negative. The clinician and roentgenologist considered the possibility of metastatic malignancy of the upper ulna (Fig. 6, *a*).

An operation was performed under tourniquet on December 7, 1934. The tumor was completely removed and the area was temporarily drained. The pathologist reported benign, foreign-body giant-cell tumor. The surgeon advised postoperative roentgen therapy. Two courses of irradiation, each over two areas, were given,—the first on December 13, 1934, and the second on January 19, 1935. The following technique was used: The roentgen rays were generated at 135 peak kilovolts, filtered through six millimeters of aluminum, at a distance of sixteen inches (forty and six-tenths kilograms), with five milliamperes of current, and were applied for twenty-five minutes.

In a letter received in March 1936, the patient said that she was well, and roentgenograms which were forwarded to us revealed complete disappearance of the tumor.

CASE 7. A boy, aged sixteen years, came to the Clinic on February 17, 1930, complaining of pain in the left arm of eighteen months' duration. He had also fractured this arm while wrestling six days previously.

Examination revealed tenderness, swelling, and abnormal mobility of the upper third of the left humerus. The patient was wearing a splint. The Wassermann test was negative; urinalysis was negative; and the blood count was within normal limits. There had been a slight loss of weight. A roentgenographic diagnosis of giant-cell tumor with pathological fracture was made (Fig. 7, *a*). Roentgenograms of the thorax were negative.

On February 20, 1930, the tumor was thoroughly excised with a curette and a bone graft from the left tibia was used as an intermedullary plug, multiple bone chips being packed around the fracture line. The pathologist reported giant-cell tumor. No subsequent treatment by irradiation, by radium, or by toxins was given.

The patient reported six years later, in January 1936, that he was in excellent health and had excellent function, and that there had been no recurrence of the tumor.

CASE 8. A farmer, aged twenty-three years, was admitted to the Clinic on May 30, 1919, because of pain in the lower part of the right femur of six years' duration. His general condition had been good and he gave no history of previous injury.

Examination revealed limitation of motion of the right knee joint and definite swelling in the lower end of the femur. The Wassermann reaction was negative; the temperature was 99.2 degrees, and the urinalysis and a roentgenogram of the thorax were negative. Secondary anaemia was present. The roentgenographic diagnosis was giant-cell sarcoma (Fig. 8). Because of the extensiveness of the mass and the involvement of the joint surface, amputation was advised, but the patient requested that an attempt be made to save the leg. On June 12, 1919, exploration was carried out under tourniquet and thorough curettage was done; the wound was closed without drainage. The pathologist reported benign, xanthic, foreign-body giant-cell tumor.

The patient continued to use the extremity and reported later that he felt that the tumor was increasing in size. His general health was good, however, and his weight continued normal. In 1925 he decided to undergo amputation, which had been advised at the time of his first consultation, and amputation was performed on April 24, 1925.

The patient reported in January 1936 that he was in good health and had had no recurrence of the tumor, almost sixteen years following the original operation.

CASE 9. A boy, aged fourteen years, was examined at the Clinic on August 20, 1927, because of limitation of motion and swelling of the left knee of one year's duration. A diagnosis of sarcoma had previously been made.

On examination at the Clinic the Wassermann test was negative; the leucocyte count was 12,900 per cubic millimeter; and roentgenograms of the thorax were negative. A preoperative roentgenographic diagnosis of osteochondroma, probably malignant sarcoma, of the left femur was made.

An operation was performed on August 26, 1927. Under tourniquet, the tumor was thoroughly removed with a curette and the knee was manipulated and straightened. Ten radium needles were inserted. The tumor had destroyed the bone posteriorly, so that the vessels were exposed and were covered only by a thin shell, which was loose. A plaster cast was applied. No subsequent treatment was given at the Clinic or elsewhere.

Almost nine years later, in March 1936, the patient reported that he had had no recurrence and was in good health.

SUMMARY AND CONCLUSIONS

The treatment of benign giant-cell tumors varies, but the physician in charge has at his disposal the means of establishing an accurate diagnosis,

following which a choice of methods is determined by the condition of the patient, the site (Fig. 9) and size of the lesion, the degree of joint damage, fracture, and the perforation or non-perforation and penetration of periosseous tissues.

Surgery has demonstrated its ability to cope with the majority of giant-cell tumors and, in the hands of the experienced, has proved its value in bringing about a high percentage of cures. Roentgen therapy has a definite place in the treatment, and in the future, the author believes, will be found of increasing value.

In this report of sixty-one cases, the lack of surgical complications, the duration of life after operation (ten and three-tenths years), and the high percentage of satisfactory results would indicate that cooperation between the clinician, the roentgenologist, the pathologist, and the surgeon makes possible the accurate diagnosis and cure of most benign giant-cell tumors of bone.

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POSTERIOR DISLOCATION OF THE HIP WITH FRACTURE OF THE ACETABULUM *

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Minor fractures about joints associated with dislocations are of frequent occurrence, but they are not often of clinical significance. However, dislocation of the hip with fracture of the rim or of the roof of the acetabulum presents a problem of importance to which little attention has been given, as demonstrated by the high percentage of poor results in those cases not efficiently treated. Of eighty cases of posterior dislocation of the hip from the author's private records, this complication was present in thirty, which shows that it is not of infrequent occurrence. Sixteen of these were fresh cases and fourteen were of many months' or years' duration. Of fifty cases of dislocation of the hip not associated with fracture of the acetabulum, twenty-seven were fresh and twenty-three were old.

FIG. 1

Type-I dislocation, five years after reduction. Excellent function. Note condensation of the acetabulum.

The thirty cases of dislocation of the hip, accompanied by fracture of the acetabulum, may be divided into three different types, as demonstrated by the roentgenograms.

Type I: This is a fracture at the superior posterior aspect of the acetabulum of an irregular, more or less triangular piece of bone. The head of the femur is subluxated slightly upward and backward. The limb may be slightly adducted or in a normal position, and motion is definitely limited, especially in abduction, which is largely due to pain elicited on passive motion. There is slight, if any, difference in position of the trochanters as related to Nelaton's line. The roentgenogram clearly demonstrates a fracture of the acetabulum, but the slight upward and backward displacement of the head of the femur may not be recognized without close inspection and comparison with a roentgenogram of the normal hip. Stereoscopic roentgenograms

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FIG. 2

A proved Type-I subluxation or dislocation. Note difficulty in distinguishing it from a normal hip.

FIG. 3

Same case as shown in Fig. 2, after reduction. Reduction was accomplished with an audible snap.

FIG. 4

Same case as shown in Fig. 3, three years later. Perfect function.

give more evidence as to the exact location of the head of the femur. Failure to recognize and diagnose the actual lesion is common, with the result that there is irreparable damage, when efficient treatment would bring about normal or almost normal relations in a very high percentage of cases. The distressing disability observed in Type I, if unrecognized, is the reason for calling attention to this subject.

Type II: The head of the femur is further displaced and is partially above the acetabulum, the lower half or two-thirds being apparently within the acetabulum, as demonstrated by the anterior posterior roentgenogram. The fragment from the acetabulum is displaced from half an inch to one inch above the acetabulum, much further than in Type I. The limb is adducted and rotated upward until the trochanter is high and abduction is nil.

FIG. 5

Type-II dislocation, showing partial dislocation of the head from the acetabulum.

FIG. 6

Same case as shown in Fig. 5, after reduction.

Type III: There is a complete dislocation of the head of the femur and of the detached fragment. The position of adduction and internal rotation and elevation of the trochanter is typical of any dorsal dislocation of the hip joint. In Types II and III diagnosis is evident from the clinical signs, symptoms, and the roentgenograms, if the average intelligence is employed.

The mechanism of injury is usually force applied from below with the hip flexed, as in an automobile collision when the knee strikes against the instrument board. Also, force acting from above with

FIG. 7

Type-III dislocation. Complete dislocation of the head from the acetabulum with marked upward and backward displacement.

the hip flexed may cause the lesion. The mechanism is somewhat different from that which usually occurs in a traumatic posterior dislocation of the hip,—namely, forcible adduction and flexion of the hip. Some facts regarding the nature of the injury were secured in twenty-four of the thirty cases. Twenty-one patients were injured in automobile accidents; of these, six gave a definite history of forcibly striking the knee against the instrument board; six gave a history of violent collision; and in eight cases the exact mechanism could not be determined. In one case only was force received from above; this injury was caused by a falling tree which struck the posterior aspect of the hip when the patient was in a stooping position. Evidently this lesion was exceedingly rare before the day of the automobile, which probably accounts for the failure in diagnosis so frequently observed in Type I.

FIG. 8

Same case as shown in Fig. 7, after reduction.

FIG. 9
Old unreduced Type-II dislocation.

The treatment for this dislocation-fracture in fresh cases is exactly the same as that employed for dorsal dislocation of the hip joint. Traction is applied in the line of deformity, which is flexion with adduction. Reduction is accomplished with a definite snap, after which movement can be made in all directions. The snap, of course, is more exaggerated as the degree of dislocation becomes greater, as in Types II and III. The fragment is evidently attached to the capsule which is approximately in the normal position after reduction has been accomplished. After reduction the hip is fixed in slight hyperextension and abduction with a cast extending from the toes on the affected side to the nipple line. This is bivalved at the end of three weeks and active and passive motion is instituted. Walking with the aid of crutches is permitted at the end of six weeks. Walking without support is begun at the end of ten or twelve weeks. Open operation was required in only three cases, one of which the author believes could have been accomplished by manual reduction.

Of the thirty patients, twenty-four were males and six were females. The age incidence was as follows:

18 years	1 case
20 to 30 years	8 cases
30 to 40 years	6 cases
40 to 50 years	5 cases
50 to 60 years	7 cases
60 to 70 years	2 cases
70 to 80 years	1 case
Total	30 cases

The average age was thirty years. There were no cases in children, although no age is exempt.

Of the sixteen fresh cases, six were Type I, six were Type II, and four were Type III. In the three cases in which open reduction was employed the end result is unknown in one case, and two cases are too recent to report on, although indications are that after three and six months, respectively, good function will be secured. Of the thirteen cases in which

manual reduction was secured, excellent results were obtained in six; the patients have active motion ranging from 75 to 100 per cent., and they have returned to their former occupations. Two cases are too recent to report on and four patients could not be located. In only one case was a poor result obtained.

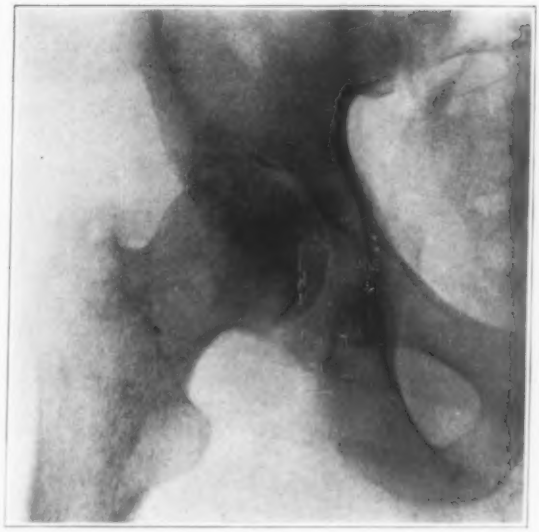

FIG. 10

Same case as shown in Fig. 9, after modified arthroplasty.

Therefore, the prognosis is excellent in a very high percentage of fresh cases, regardless of the type, if efficient treatment is instituted at once. In one case (Type 1) with an excellent functional result, there was definite condensation of the upper and posterior rim of the acetabulum after the lapse of five years. Presumably this occurs in all cases, but no patient has returned on account of local osteo-arthritis.

There were fourteen patients with old dislocations; eight of these submitted to open operation. Three types of operation were employed: (1) open reduction with reconstruction of the acetabulum; (2) a partial or modified arthroplasty when the head of the femur was still invested with cartilage; (3) a complete arthroplasty, which consisted of completely remodeling the head of the femur and the acetabulum. The end results in these eight cases were far from satisfactory. The best results were secured in two patients who had complete arthroplasties; in the remaining

FIG. 11

Same case as shown in Fig. 10, one year later, showing degenerative changes of the head of the femur. The hip was painful.

FIG. 12
Old unreduced Type-III dislocation.

FIG. 13
Same case, after reconstruction of the acetabulum. The hip was painful.

FIG. 14
Old unreduced Type-I dislocation.

FIG. 15
Same case as shown in Fig. 14, after complete arthroplasty. Fair functional result.

six cases the results were poor, as slight, if any, improvement was obtained. As stated in former contributions, partial arthroplasties are unsatisfactory, since articular cartilage rapidly degenerates when removed from a joint cavity and leaves a poor foundation for a new joint. The circulatory changes result in disintegration and a painful hip.

Undoubtedly induction of osseous fusion of the hip joint would give the highest percentage of excellent results; in each case this measure was offered, but it was flatly declined when the patient was told that there was a possibility of function with the use of any other procedure.

CONCLUSIONS

1. The relatively frequent occurrence of fracture of the acetabulum associated with dislocation of the hip is demonstrated by the fact that it was present in 37.5 per cent. of this series of cases. Prior to the time of the automobile this lesion was rare.

2. Many dislocations, especially those of Type I, are not recognized until there has been irreparable damage, of which only partial restoration is ever possible. The fourteen old cases demonstrate the poor end results which may be expected from inefficient treatment.

3. With an early diagnosis and efficient treatment, excellent function should be secured in practically every case.

THE TREATMENT OF SURGICAL TUBERCULOSIS BY VASELIN INJECTIONS AND CLOSED PLASTER-OF-PARIS BANDAGES

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The treatment of surgical tuberculosis has undergone many changes in its development, extending over a considerable period of time. Along with the rapid progress made within the past century, the opinion that tuberculosis should be treated surgically was generally accepted. In an otherwise successful period of radicalism much harm resulted in the field of bone and joint tuberculosis. Foci of this disease were freely opened, the site of the disease eradicated, and the articular surfaces, even in the florid cases, resected; in brief, every effort seemed to be directed to a mechanical removal of diseased tissue and the causative organisms. As might have been expected, the results were unsatisfactory. Miliary metastasis was frequent, often causing death. Cold abscesses, which were widely incised, in spite of the strictest asepsis in the after-dressings, became secondarily infected with pus-producing organisms, thus perpetuating a purulent discharge which drained the patient's vitality until, in many cases, death ensued from amyloid degeneration.

These fatalities led those who opposed this course, either from conviction or from personal distaste for operation, to seek new methods of treatment. Calot declared: "If you open tuberculosis you thereby open the door for death." The conservative method won the battle and became an unwritten law in spite of the contrary opinion of prominent authorities. A new method of treatment was adopted,—namely, complete rest, either in plaster-of-Paris bandages or by extension. Much effort was spent in the search for new methods of vaccination and, although these efforts often led to good results, the desired goal was not attained. It would seem, therefore, that a more active course of treatment should be sought which would hasten recovery and yet not endanger the life of the patient.

In this paper the author wishes to consider those types of surgical tuberculosis which present grave obstacles to actual surgical interference. To this group belong para-articular foci of tuberculosis.

As the writer has already stated in an article devoted to these interesting types of bone tuberculosis, operation is indicated in such cases only when the roentgenogram shows distinct signs of a circumscribed cavity. We know from experience that the clearing out of such a focus is not dangerous, but before the cavity limits itself a sequestrum forms within. The sequestrum appears so often that Sorrel, in his monograph, lists it as an obvious sign of the focus of tuberculosis.

Sequestra, especially the larger ones, have a tendency to spontaneous

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evacuation; only the smaller sequestra may be absorbed. That is why fistulae are often found near such a focus. A fistula often announces a disease of the bone when up to that time there have been only slight, if any, symptoms. A little carelessness on the part of the patient, or of those about him, may be sufficient to disclose foci of disease which have been draining for weeks. Unfortunately, this happens quite often, so that we frequently see fistulae which have been pyogenically infected. Similarly, cases of caries calcanei and spina ventosa of short and long bones are met with in which incisions, made too late by the surgeon, have led to secondary infection.

In treating these and other complications, followers of conservative trends were satisfied by the application of a plaster-of-Paris bandage with an aperture for the fistula, through which the dressings were changed. Thus, treatment resolves itself into a question of clean dressings; these, however, are purely aesthetic and do not prevent superinfection. The author considers it necessary to eradicate the foci even if secondary infection has taken place or if the abscess has not yet broken through. Conservative treatment is too prolonged and too passive, does not prevent the possibility of eventual extension into the joint, and is, therefore, unsatisfactory.

The writer's procedure is as follows: The patient is prepared in the customary manner and a wide operating surface is disinfected with tincture of iodine. If there are no fistulae, the foci are incised and eradicated. After removal of the diseased tissues, the cavity is tamponed with gauze moistened with physiological salt solution. After the hemorrhage has been stopped, the cavity is dried and filled with sterilized vaselin. Suture of the skin is but partial, so that the secretion may drain away. If no fistula is present and there is only an abscess to deal with, the procedure is the same: the abscess is opened and the cavity is scraped with a sharp spoon and filled with vaselin. Rinonapoli followed a similar procedure in five of his cases except that he did not disinfect the bone foci and he filled them with gauze saturated with vaselin. In all cases he obtained successful results, curing his patients in from four to six months. However, this drainage does not seem adequate. The author considers the introduction of gauze, as in osteomyelitis, harmful, since it prevents secretion and irritates the bony tissue. Vaselin itself drains so efficiently that it can be used without concern even in those cases in which the cavity has had a secondary infection. The use of vaselin alone does not require redressing of the wound, since, in the process of healing, the vaselin is forced out. Therefore, the bone is entirely unmolested, which is desirable for healing. It is the writer's belief that filling the cavity with vaselin is proper even if no fistulae are present. Vaselin then acts as a filling.

The need of filling bone cavities has always been recognized and various suggestions as to the ingredients have been offered. The principal reason for filling the cavity is to replace the defect with material similar to osseous tissue which, through osteoblastic activity, will supply the basis

for a quicker compensation of the defect. Secondly, the filling is supposed to restore the disturbed stability of bone and at the same time to act as a preventive to infectious agents in the cavity. A fault of all or most of these prescriptions for fillings has been the admixture of disinfecting materials. Such fillings naturally represent foreign bodies which irritate and cause reactions that end in elimination.

Fillings, as they were formerly employed, had one undeniably favorable result in cavities which were infected: they prevented the bone defect from filling with blood. Bearing this in mind, the author began to use vaselin chiefly to prevent formation of hematomata and to establish a continuous communication between the osseous cavity and the exterior. If the cavity can be kept from filling with blood, a means is at hand for preventing the increase of microbes upon favorable ground. Vaselin as a filling material has in this respect proved very successful. Bone tissue bears it exceedingly well because of its neutrality and non-irritability.

The following cases have been treated according to the method described:

CASE 1. J. C., a boy, eight years of age, was admitted to our Clinic on November 8, 1934, with a history of having had pain since July 1934 in the lower part of the right forearm, which was swollen. The pain had continued day and night. An abscess had formed and had been opened and cleaned out in another hospital. Both incisions had drained for a long time and fistulae were present. The family history was negative.

Roentgenographic examination (Figs. 1-A and 1-B) revealed juxta-articular tuberculosis of the lower end of the right radius. The focus was irregular and oblong in shape. It was limited by the metaphysis and partly involved the metaphysis, the adjacent diaphysis, and the epiphysis. The disease had probably been present for a long time, although this could not be determined from the history.

On November 9 the lesion was eradicated according to the procedure described, followed by the application of a plaster-of-Paris bandage, with the hand in the functional position. The histological finding was tuberculous, caseous productive osteomyelitis.

The postoperative course was favorable; the patient was without fever and was discharged on the twelfth day. Six weeks later the wound was redressed. On the volar side was a smoothly healed scar and on the dorsal side, a granulating surface. This dressing was not disturbed for six weeks. At that time, both incisions had completely healed. Roentgenographic examination showed the areas of rarefaction to be filling up. Another plaster-of-Paris bandage was applied and left in place until March 3, 1935, when the roentgenograms (Figs. 2-A and 2-B) showed the lesion to be healed.

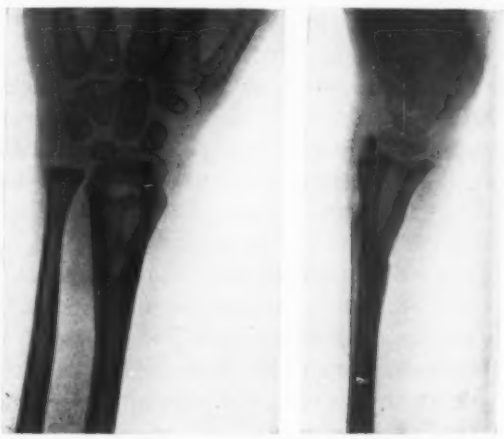

FIG. 1-A FIG. 1-B

Case 1. J. C. November 8, 1934. Juxta-articular tuberculosis of the lower end of the right radius.

CASE 2. M. P., a girl, three years of age, was seen in our Clinic

FIG. 2-A

FIG. 2-B

Case 1. J. C. March 3, 1935. Lesion healed.

in December 1934. The mother had given birth to the child out of wedlock and had nursed her for six weeks only. The mother suffered from pulmonary tuberculosis to which she succumbed when the child was two years of age. The first symptoms of the disease in the child had manifested themselves in the spring of 1934. In walking she inverted the right foot and limped slightly. In the summer of 1934, the outside of the left ankle began to swell. The child was treated in the Out-Patient Dispensary of another institution. A plaster bandage was not applied.

Roentgenographic examination at our Clinic showed the focus of the disease to be located in the right heel bone (as is quite typical in children) on the posterior and upper surface of the calcaneum. An abscess was present on the outside of the ankle.

The focus of disease was eradicated, the abscess was drained through a short incision, and a plaster-of-Paris bandage was applied. The diagnosis was confirmed histologically.

After the second dressing, three months later, the abscess healed with a smooth scar. The postoperative course was favorable; there was no fever. The area of the lesion filled completely after four and one-half months. Before complete healing took place, however, a new focus was found in the upper metaphysis of the tibia, which also involved a large part of the epiphysis. Again a subcutaneous abscess developed. Eradication was performed on February 20, 1935. The course was again favorable. Toward the end of May, the patient contracted scarlet fever and disappeared temporarily from our observation. In September 1935 the focus in the tibia had healed perfectly.

This case is particularly interesting because of the fact that healing was obtained in a comparatively short time, although we were dealing with a weak child with poor resistance.

In June, July, and September 1935, additional eradications of para-articular lesions in various localities were made in the manner described. In three cases large lesions of the femoral neck were found, which threatened to penetrate the joint. In these cases the eradication was made through a small opening in the greater trochanter. At the same time it was necessary to excise the sound part of the neck. The cavities were filled with warm vaselin and only a small opening was left for the outflow of blood. In each case a plaster-of-Paris spica was applied to the hip. The postoperative course in each case was satisfactory. In November 1935, check-up examinations of the patients showed healing of the wounds and an advanced degree of regeneration of the osseous tissue in the eradicated cavities.

In addition to these cases, eradications of para-articular lesions in the upper part of the tibia and in the outer condyle of the femur have been performed. The detailed history of these cases is not included because

only a short time has passed since the operations. Nevertheless, we consider all these cases to be healed and we feel ourselves authorized to affirm this because all the follow-up roentgenograms have revealed a rapid regeneration of the osseous cavities.

The difficulties encountered in treating localized bone foci are slight, however, as compared with those met with in cases of florid infection of articulations in which abscesses or fistulae have formed. Articulations cannot be opened by operation without endangering the patient. The focus of pus production is, therefore, unapproachable. There is no way of preventing the ample flow of secretion from the fistulae. An enormous secretion with its foul odor and offensive appearance requires frequent redressing which leads to infection of the fistulae. Although theoretically the rule is that dressings should be absolutely aseptic, practically this is not always possible. The fistulae and their surroundings can be kept without secondary infection only for a limited time, but the abscesses drain for months and even years. Mechanical cleaning and disinfection irritate the skin, no matter how carefully they are done. Bone tuberculosis, even when not infected, heals very slowly. An added infection causes the secretion, as well as the temperature, to increase. The patient loses appetite; his bodily resistance is lowered; he begins to fail; and not rarely he dies.

And what about closed abscesses? The physician works in constant fear of fistulae, constant fear of superinfection. Therefore, careful remote puncture through non-diseased tissue should be the procedure. Injections of various solutions which are supposed to thin out the contents of the abscess, as well as aspiration of the pus, are often not entirely successful. The fundamental fault of this procedure is the continued disregard of the basic principle in the treatment of surgical tuberculosis,—that the site of tuberculosis should be given absolute rest.

In our Clinic treatment in cases of closed foci where redressing would be necessary was given up until after immobilization had been accomplished by plaster splints. After the abscess had been cleaned out, the plaster dressing was reapplied. The more the abscess filled or the more profuse was the secretion through the fistulae, the more frequent were the redressings or punctures and the less certain was the success of the treatment.

These facts necessarily led to a consideration of how best to circumvent these obstacles. The first attempt at solving the problem was made by Solieri in 1912. He suggested the application of plaster-of-Paris bandages, regardless of the secretion of the fistulae. In brief, his procedure is as follows: extraction of the sequestra, puncture of the abscesses, rinsing of the abscess cavities and fistulae with Durante's solution, protection of the skin directly around the fistulae with astringent salve, absorption of the pus with a layer of gauze and cotton batting, and the application of plaster-of-Paris dressings. In 1929 he reported that since 1912 he himself had treated a total of thirty-two patients. Of these, twenty-four were cured; four had died; and in four cases the treatment

was unsuccessful. Other authors who have reported the successful use of Solieri's method, either in its original or modified form, are: Calcagni, Capecchi, Conti, Mannarini, Marinescu, Benci, Tedeschi, Kofmann and Tarlo.

Complete rest in plaster and autovaccination produced by the accumulation of pus on the skin are factors which, in accordance with the opinions of these authorities, act favorably on the healing of the fistulae and the primary focus. No consideration whatsoever is given to the question of secondary infection, which should not be disregarded. Thus one can explain the considerable maceration of the skin with pus, but, according to the Italian authors, this maceration is favorable, so that some of them make no attempt to prevent it. They believe that the most successful results are obtained by vaccination of the diseased skin with pus from the wound itself. Experience has taught us that cutivaccination in tuberculosis does not work favorably. Unfortunately, the author's information is based only on reports, since all scientific works which deal with Solieri's method have appeared in Italian periodicals which are not available in Czechoslovakia. Therefore, the writer does not know to what extent the skin is covered with salve and what kinds of salve are used. The author does not wish to deny the importance which the Italian authors ascribe to the continuous contact between pus and the irritated skin; however, he certainly prefers to see the skin non-macerated rather than macerated. The writer does not know how intensive the maceration is when the skin is covered with astringent salves, but, judging from the work of Lačný, it is very considerable. The appearance of the skin was such that, in combination with the bad odor and other unfavorable circumstances, it made him abandon and condemn Solieri's method which he tried in four cases. Lačný, however, made the mistake of not trying to maintain the time intervals between individual dressings as Solieri had prescribed. Lačný is also the only author who was disillusioned with Solieri's method. In our judgment, also, Solieri's method has its unfavorable aspects. The gauze is put directly on the opening of the fistula and covered with a soft dressing, purposely thin. The plaster is modelled to fit closely, so that either the secretion cannot drain at all or else it drains with difficulty. This explains the occasional rise in temperature noticed by other authors in using Solieri's treatment.

The following method seems to the author to avoid the disadvantages of Solieri's treatment: The skin is first disinfected over the largest possible area with tincture of iodine. If a cold abscess is present, an incision, from two to three centimeters in length, is made. Through this opening a spoon is inserted, the walls of the abscess are thoroughly scraped, and the cavity is tamponed with gauze moistened with a physiological salt solution. After the bleeding has been stopped, the cavity is filled with vaselin in semi-liquid form, partially warmed. The semi-liquid vaselin adheres to the walls of the cavity and forms a perfect drain. The skin about the wound is covered with a thick layer of vaselin, so that there remains

uncovered in the vicinity of the wound not a spot which the pus could touch during the ensuing weeks. Any unprotected area would assuredly be macerated by the pus. Especial emphasis should be placed on the fact that it is unwise to spare vaselin when coating the skin. Over the wound is placed a layer of sterilized gauze and cotton batting, preferably thicker than an ordinary dressing. A thick layer of covering material soaks up the vaselin and enables the pus to drain into the upper layers which are to absorb the pus. A well-molded plaster-of-Paris dressing is then applied in which the adjoining two articulations are included.

If there are fistulae near the diseased articulation, the openings are merely widened and the entire fistulae are scraped. The procedure which follows is the same as that already described. It is not advisable to change the plaster-of-Paris bandage before the end of six weeks.

The suggested modification of Solieri's method seems to the author to be very favorable for the following reasons:

1. It takes into account the possibility of secondary infection. The sterilized covering of the fistula forms a closed space under the plaster cover for the gathering pus. Secondary infection cannot penetrate the plaster dressing. The question of infection or non-infection of the site of tuberculosis seems of primary importance.

2. If bone or articular tuberculosis, pyogenically infected, is encountered, the vaselin ensures as perfect a drainage as can be desired. It is necessary to drain without gauze.

3. In this method of treatment there is no danger of retention of pus; therefore, even in foci infected pyogenically, one may employ the most important weapon in the treatment of bone tuberculosis,—perfect immobilization in a plaster-of-Paris bandage.

4. After the festering wounds have been filled with vaselin, a rather slight amount of pus has been noted under the plaster-of-Paris bandage. The secretion is usually most marked during the first week and the dressing is soaked through. During the second week the secretion is less and it gradually decreases in amount. This fact naturally has more bearing on the pyogenically infected wounds. One certainly cannot compare the secretion which is encountered during the dressings with that previously met with when redressing was done every other day. In so serious a disease, the great decrease in albumin caused by hyperproduction of pus is certainly not to be disregarded.

It seems to the author that rinsing and various antiseptic solutions are improper and dangerous methods of treatment. Certainly, in most cases, such a disinfectant rinsing does not reach any farther than the abscess cavity; the focus is reached only partially by the application of pressure, which should not be used. It is well known that, because of their alkaline reaction and other reasons, certain abscesses are unfavorable ground for the growth of Koch's bacillus. Bacilli are rarely found in abscesses; rinsing, therefore, is superfluous and the writer cannot agree with Solieri.

A frequent objection to the healing of wounds by confinement in plaster-of-Paris dressings is the bad odor. True, the odor of the bandage, which seals the pus for a long time, is very offensive. It annoys those about the patient, but seldom troubles the patient himself. It is the only serious objection to this treatment. However, if the treatment is benefiting the patient, the bad odor ought not to be a cause for removal of the plaster-of-Paris dressing. It is probable that some other ingredient may be found which, when mixed with vaselin, will neutralize the odor. Löhr combined cod-liver oil with vaselin and attributed his successful results to the healing properties of the oil. However, although cod-liver oil somewhat neutralizes the odor, the author has observed no better results from the use of this mixture than from pure vaselin. In fact, he has often noted maceration of the skin following the application of cod-liver oil, which is not the case when vaselin alone is used.

It is unquestionably advantageous to give vitamins during bone diseases, but they should be given by mouth. It seems to the author very unwise to risk infection by filling the wound with unsterilized cod-liver oil. Löhr contends that cod-liver oil is practically sterile and that it kills pyogenic flora. However, according to the very thorough and careful experiments carried out by Patočka and Görtzen, cod-liver oil, paraffin oil, and vaselin have not the slightest bactericidal properties.

The following cases have been treated according to the modification of Solieri's procedure which has been described.

Case 3. V. M., a girl, aged fourteen years, was admitted to our Clinic on November 7, 1934. At the age of nine, she had had inflammation of the left hip. Two and a half years later, healing by ankylosis took place in a position of flexion and adduction. In October

Fig. 3-A

Fig. 3-B

Case 4. B. M. Advanced destruction of the olecranon and of the head of the humerus.

1934 the patient had fallen and had injured the left trochanter, and in November pain had developed.

On admission, examination showed the region near the greater trochanter to be swollen. The skin was reddened and fluctuant. Roentgenographic examination revealed a large lesion in the trochanter.

Diagnosis: Ankylosis of the left hip; recurrent coxitis; a cold abscess in the region of the greater trochanter.

A short incision was made and about 200 cubic centimeters of pus was drained from the abscess. The carious cavity was curetted and filled with vaselin. A plaster-of-Paris bandage was then applied.

The postoperative course was uneventful; there was no fever. Three months after operation, the patient had gained in weight and her general condition was good. The incision had healed with a smooth scar and the skin was dry. The contour of the trochanter was sharply defined. A roentgenogram showed that the area of rarefaction was beginning to fill. In April 1935 the focus in the trochanter had filled, so that it was possible to perform a subtrochanteric osteotomy of the femur to correct the malposition of the limb. In the middle of May a short plaster-of-Paris bandage, reaching to the knee only, was applied, and the patient was discharged. Weight-bearing was allowed

Case 4. B. M., a woman, sixty-three years of age, was admitted to the hospital on December 11, 1934. She gave a history of having been in good health until five years previous to admission, when the right elbow joint had become swollen and attempts to move it had resulted in great pain. Treatment had consisted in the application of a plaster-of-Paris bandage, but this had been allowed to remain for about two months only. The pain had been bearable and there had been only occasional fever. Since the beginning of 1934, she had grown considerably worse,—the joint had swollen and on the outer side a fistula had formed which drained pus. The patient ran an evening temperature. Her husband had died of tuberculous peritonitis.

On admission, the following findings were noted: obliteration of the contours of the joint, doughy swelling on the outer side,

Fig. 4-A

Case 4. B. M. Resection of the humerus above the trochlea at about the middle of the coronoid fossa.

Fig. 4-B

Case 4. B. M. Resection of the ulnar joint surface, the olecranon, and the head of the radius.

FIG. 5-A

FIG. 5-B

Case 4. B. M. Showing range of motion possible after operation.

and a small fistula from which thin pus drained. Passive motion was very painful and the range was as follows: extension, 110 degrees; flexion, 90 degrees.

Roentgenographic examination (Figs. 3-A and 3-B) disclosed advanced destruction of the olecranon and of the head of the humerus.

Diagnosis: Tuberculosis of the right forearm with fistula.

At operation on December 12, 1934, the right elbow joint was exposed by Farabeuf's incision. A resection of the humerus above the trochlea, at about the middle of the coronoid fossa, was then performed. Of the forearm bones, the entire joint surface of the ulna, with the olecranon and the head of the radius, was resected,—the typical resection of Ollier. (See Figures 4-A and 4-B.) In addition, the nearby diseased soft tissues were removed. The space between the ends of the bones was filled with vaselin; the muscles and tendons were sutured; and the skin was left with an opening above the joint for drainage. A plaster-of-Paris bandage was applied with the arm in 100 degrees of flexion.

The postoperative course was very favorable. The pain disappeared. After six weeks the dressing was removed. The skin had healed, and active exercises were begun. Three months after the operation, following daily massage and exercise, a very adequate range of motion resulted (Figs. 5-A and 5-B). Flexion, extension, pronation, and supination were possible to an almost normal degree and without pain. In May 1935 the patient was able to carry light objects with the arm which had been operated upon.

CASE 5. B. C., a male, twenty-four years of age, was seen in October 1934 with a history of having suffered an injury in the region of the right hip in December 1933. There had been no immediate consequences. On April 6, 1934, he had suddenly felt ill, had fainted, and had fallen down. Three weeks later, in the hospital where he had been taken care of, an abscess had been found in the right inguinal region, extending as far as the femur. The abscess, which was evidently cold, had been opened by two wide incisions,—one in the inguinal region, the other on the exterior side of the thigh. From the draining wounds, the secretion of pus had been abundant. The temperature, which at first had been subfebrile, became very high after the occurrence of secondary infection. The family history was negative.

When seen by the author, the patient's condition was very unfavorable. The

FIG. 6

Case 5. B. C. Showing condition in March 1935, when the wound was first redressed.

temperature was above 39 degrees centigrade. The patient was pale and very much exhausted by fever. The right hip was swollen considerably. The most striking feature was the swelling in the region of the trochanter, which was indurated and oedematous. In the middle of the incision in the right groin was located a craterlike fistula from which a large amount of yellowish-gray, foul, viscid pus drained. The area surrounding the fistula was reddened. From a similar fistula on the outer side of the thigh large quantities of pus were also draining.

Diagnosis: Inflammation of the right hip with fistulae, due to secondary infection; osteomyelitis of the head and neck of the femur; pathological dislocation of the right hip.

Roentgenographic examination (Fig. 7) confirmed this diagnosis.

On November 11, 1934, under anaesthesia, a trepanation of the femur was performed, close to and below the trochanter. Through an adequate opening, an eradication of the disease in the neck and head was successfully accomplished. The incision was left open, and the cavity and soft parts were filled with vaselin mixed with cod-liver oil after the method of Löhr. The fistula in the inguinal region was excised and filled with vaselin. Staphylococcus albus was found in the pus. On the fifth day after the operation, the temperature was lower, and later reached only subfebrile levels. It remained in this rather satisfactory condition until January 11, 1935, when it again rose to 39 degrees centigrade.

On January 25, 1935, another operation was performed. The incision in the inguinal region was widened and that on the outer side of the thigh was opened again and a new incision made on the ventral side with a connection between them, so that adequate drainage of the secretion was thus guaranteed. The bones were not incised. The cavities were filled with vaselin and cod-liver oil. The temperature remained high during the first week after the operation and then became subfebrile.

When the wound was redressed early in March, the bandage was found to be thoroughly soaked and the odor was very offensive. Although the incisions were mostly filled with granulations, they secreted considerable pus. (See Figure 6.) The skin of the upper half of the thigh was greatly macerated. This condition convinced the author that the mixture of vaselin and cod-liver oil is not a suitable covering for the skin, for it irritates rather than protects. A dressing with pure vaselin was then applied and left undisturbed until May 23, 1935. At this time it was obvious that the secretion had

FIG. 7

Case 5. B. C. Pathological dislocation of the right hip, due to osteomyelitis of the head and neck of the femur.

FIG. 8

Case 5. B. C. July 28, 1935. Showing ankylosis of the right hip joint and recalcification of the head and neck. An irregular shadow of lipiodol may be seen within the pelvis near the head.

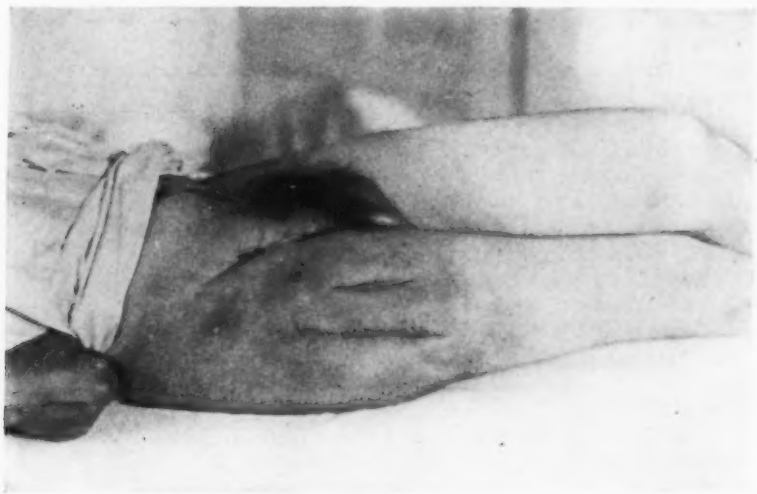

FIG. 9

Case 5. B. C. July 28, 1935. The incisions have healed with smooth scars.

considerably decreased. The patient had gained weight and felt well. The maceration of the skin had disappeared. The incisions in the inguinal region and on the ventral side had healed. On the outer side of the leg there still remained a small granulating surface.

Another bandage was applied, which was not changed until July 28, 1935. At this time all of the incisions had healed with smooth scars. (See Figure 9.) On the same day roentgenographic examination (Fig. 8) showed ankylosis of the hip joint in quite good position and advanced recalcification of the head and neck. Signs of the eradication were evident only at the trepanation aperture near the trochanter. In the pelvis, near the head, was visible an irregular shadow of lipiodol.

CASE 6. J. M., a male, eighty years of age, was admitted to the Out-Patient Dispensary in February 1934, because of swelling of the right ankle joint. The swelling had first become apparent after an accident in July 1933. It did not disappear even after a long period of immobilization and the application of Priessnitz dressings. In September 1933 the patient had been treated with hot baths, because the illness had been taken for a uratic affection.

Diagnosis: Tuberculosis of the right tibio-astragalar joint with fistula.

A plaster-of-Paris bandage, with an opening, was applied and through this opening the dressing was changed. In November 1934 the treatment which has been described was started. On July 2, 1935, the fistula was found to have healed.

In addition to the cases reported, eight similar cases are now being treated. In all of these, great improvement has been noted after the first dressing.

NOTE: Much of the material in this article, as well as the cuts included, appeared in *Slovanský Sborník Ortopedický*, X, 54, 1935, and is reproduced by permission of the editor of that journal.

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ARTHRITIS AS A TEACHING PROBLEM *

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For many years arthritis has been one of the major problems with which the orthopaedic surgeon has been called upon to deal. However, it is not the treatment of arthritis that is the concern of this paper, but our final Hippocratic duty in regard to it,—namely, to train the oncoming generation of students to meet and, perhaps, to solve this terribly baffling puzzle. Medical literature is witness to the variety and many-sidedness of the conditions we glibly group under the term "arthritis", which render it a veritable wilderness to the unexperienced and unguided student. With so indeterminate a subject and with so little time to waste in teaching, is it not important to put to ourselves four primary questions for honest answer before we go before our students or even before our peers?

I. What Is Arthritis?

Each one would give a different answer probably, and that answer would be the foundation of his teaching. The answer which seems most honest to the author is that, when the joint inflammations of *known* etiology have been excluded, arthritis is just good old-fashioned rheumatism, a symptomatic term honest in its vagueness and lack of pseudo-scientific presumption. That the various joint manifestations in arthritis —pain, swelling, heat, osteophytes, etc.—are symptoms of some systemic disorder affecting the individual as a whole is a fact which anyone who has seen a real case of Still's disease, rheumatoid arthritis, arthritis deformans, or gout cannot escape realizing. Why is it that in mild or early cases we fail to recognize this same fact,—namely, that we have a systemic illness to deal with and not just a sore joint or two? Yet one invariably gets the impression in meetings or clinics that arthritis is a *disease* in itself rather than a symptom probably common to a number of infectious diseases and metabolic disturbances. Our position in regard to arthritis is comparable to that of the doctors of a century ago with regard to fever with its various clinical classifications,—such as hectic, puerperal, tertian, breakbone, etc. An honest statement of the protean character of arthritis and the difficulties arising therefrom will prove much more enlightening and stimulating to questioning students than artificial classifications and halting explanations.

II. Who Is to Teach Arthritis?

Having taken the ground that arthritis is merely a joint manifestation of an underlying systemic condition, to be consistent one would have to admit that the physician rather than the orthopaedic surgeon should

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be the one not only to treat it but to teach it. Practically, this does not work out well for two reasons: first, the medical staff of a university already has the major teaching burden and is put to it to cover adequately the very wide field of general medicine; second, the medical wards cannot be filled with such long and chronic cases as arthritis, which means that there is a paucity of clinical material at hand for the Medical Service to use in teaching.

If it is not to be the Medical Staff, then, of necessity, the Orthopaedic Staff seems to be the victim. Our teaching field is smaller and we should welcome this opportunity to make an excursion into the medical territory, to revert again to our primary rôle of physicians, and to escape temporarily from the narrow confines of a surgical specialty. We certainly have a wealth of teaching material in our clinics and wards and in those special institutions which we serve that are separate but allied to the central teaching hospital. Every Orthopaedic Children's Hospital has its quota of Still's disease, and a "Home for Incurables" or a Chronic Hospital can supply a wealth of tragic arthritic end results. It should be our constant endeavor, however, to secure the support and help of the medical staff in the teaching as well as in the treatment. In this subject we ought to regard ourselves as liaison officers between the armies of medicine and surgery.

III. Where Is Arthritis To Be Taught?

There are four ways to present problems to the student: (1) in lectures; (2) in ward classes; (3) in the dispensary clinic; and (4) in the literature and in the laboratories.

For our purpose each has its special use. One or two lectures seem to be definitely needed in order to present the complexity of the problem, to tell the story of progress made, to present the fundamental pathological lesions *in vivo* and *in vitro*, and to show a few cases illustrating the great variations encountered. Ward classes give us an opportunity for much greater detail of examination and allow us to present the necessary studies and laboratory aid required. They also give us a chance to emphasize the individuality of each case and to direct the student's attention to the multitudinous factors which play a rôle in the patient's illness. Both lectures and dispensary teaching deal too broadly or too hurriedly with patients to fasten this principle in the student's mind. However, the dispensary, with its hurly-burly and volume, gives us a chance to see the early mild case as well as the old cripple, and in this way adds the proper depth of perspective to the pictures which we wish the student to carry away.

Finally, how shall we guide these students in literature and in research? This is perhaps the hardest problem, as the literature is so muddled by diverse terminology and the research problem is so complex that adequate direction is almost impossible. The author's advice is for the seriously interested student to read everything and believe nothing.

If a man reads widely with reference to arthritis, he will be made aware of many theories, explanations, treatments, and cures, but let him beware lest some therapeutic Circe enchant him and enslave his errant curiosity in the mental sty of a fixed idea. Only by critical observation and careful analysis will our riddles be solved, so a staunch skepticism must be maintained in the presence of the printed word. Independent laboratory research should be discouraged until such a time as observation and clinical experience have given the beginner some lead which he himself is keen to test and follow. There is no doubt that a great deal of our confusion has arisen from the desire of the laboratory worker to find something which can be published, rather than to find the explanation for himself of some suggestive clinical observation which he has made.

IV. How Is the Subject To Be Taught?

It can be taught dogmatically, in an *ex cathedra* manner, but in the average medical school this is not safe. The professor is too vulnerable in this particular subject to assume omniscience, and the established facts about which one can be dogmatic are few and far between.

It can be taught as if one were an advocate, pleading the righteousness of a theory or of a method. But this, too, is dangerous unless one tempers one's enthusiasm with an occasional candid reflection that after all one's pet thesis may be wrong, and an innocent organism may be lynched or an inconsequential joint may be twisted for no permanent scientific gain.

One can teach it as an experimenter, a sound and honest but not very tangible way to present a complex subject to the student, the danger being that the student will get only a narrow viewpoint of a large subject.

Or, one can expound it as a philosopher, viewing the subject broadly and dispassionately, pointing out where one can distinctive and helpful land marks (both clinical observations and experimental findings), following the leads of theories as far as one can see clearly, examining the effects of various types of therapy advocated at this clinic and that, suggesting a possible trail to follow in future experimentation, but, above all else, avoiding the semblance of speaking with authority on a finite disease.

In conclusion, the author wishes to present for consideration a scheme which so far he has found more satisfactory than any other in conveying to the student his conception of arthritis.

This scheme likens the arthritides to a spectrum, the red end being represented by acute rheumatic fever and the violet end by gout, with a complete but gradual variation in shade and type in between. Certain particular bands, like the post-tonsillitis, subacute arthritis in the reddish area of the spectrum or the bluish osteo-arthritic group, stand out boldly it is true. As long as one has to deal with rheumatism on the basis of clinical findings there can be no accurate hard and fast classes, so that the colors of the spectrum, shading from one into the next without any line of demarcation, give us a graphic method of putting our conceptions before

TABLE I

A GRAPHIC METHOD OF CLASSIFYING THE ARTHRITIDES

Clinical Manifestations	Spectrum	Type of Arthritis
	Infra-Red	
No resultant joint change	Red	Acute rheumatic fever
Joint changes of proliferative type		Acute infectious arthritis—relation to focal infection clear
	Orange	Subacute infectious arthritis—relation to focal infection indefinite
		Still's disease
	Yellow	Rheumatoid arthritis
Atrophy		Atrophic arthritis
		Arthritis deformans
Mixed changes	Green	Villous arthritis
		Serum or allergic arthritis
		Arthritis associated with endocrine disturbances
	Blue	Arthritis associated with chronic traumatization
Degenerative type of joint lesion		Marie-Strümpell arthritis
		Hypertrophic arthritis
Crystalline deposits	Violet	Osteo-arthritis
		Gout

the students without artificially separate categories. The student comes for help with a jumble of terms in his mind, and by means of this method we try to fit these terms into one another and into our spectrum.

Not only is this method convenient for assorting cases when first seen, but it allows for the chameleonlike changes observed in individual cases as they run their course and vary from month to month,—such as the infectious type which progresses slowly to crippledom and atrophy. Mixed conditions often occur, and, by mixing shades of simple conditions, one can match the complexion of any individual case. The spectrum also brings out the protean character of arthritis mentioned earlier, one of the facts that it is important to impress on students.

TREATMENT OF MALUM COXAE SENILIS, OLD SLIPPED UPPER FEMORAL EPIPHYSIS, INTRAPELVIC PROTRUSION OF THE ACETABULUM, AND COXA PLANA BY MEANS OF ACETABULOPLASTY*

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In February 1935 a patient, aged fifty-five, was admitted to the Orthopaedic Ward of the Massachusetts General Hospital with the diagnosis of "bilateral intrapelvic protrusion of the acetabulum". The case was discussed on ward rounds and the general opinion was that nothing could be done for this patient, and that she would have to adapt her life to the hip-joint condition. This did not seem a constructive attitude, and the patient was allowed to stay on the ward in the hope that some operative procedure might be developed which would give her relief from pain.

The question to be answered was this: "What is the source of this patient's pain?" The answer was: "The impingement of the femoral neck on the anterior acetabular margin". Such impingement would result in "traumatic arthritis" with characteristic changes of the joint surfaces as well as of the synovia. Since the joint surfaces have no nerve endings, their function in itself cannot be the source of the pain; as they slide over one another, even though the hyaline cartilage is markedly thinned, they will not give rise to symptoms. What does give rise to pain? The impingement of two surfaces—one covered by synovia, the other by cartilage—will give rise to congestion of the synovia, synovitis, and, because of periosteal irritation, hypertrophic changes.

The following analysis gave us the answer to our problem: If we could eliminate this impingement, we should be able to eliminate the resultant reactions and, therefore, pain. To eliminate impingement two regions may be attacked,—the neck of the femur and the anterior margin of the acetabulum. To eliminate impingement by a plastic procedure on the neck of the femur would be impossible, since this would sacrifice too large a portion of the neck. (See Figure 1.) What would be the effect of removing the anterior wall of the acetabulum? By sacrificing a small portion of this structure, a wide range of motion would be gained. This, then, seemed to be the answer to our problem. The patient was informed that the operation had never been performed before, but that it did offer a chance of success. She accepted the operation willingly. In four weeks she left the hospital walking, and in four months she returned to her work

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, St. Louis, Missouri, January 14, 1936.

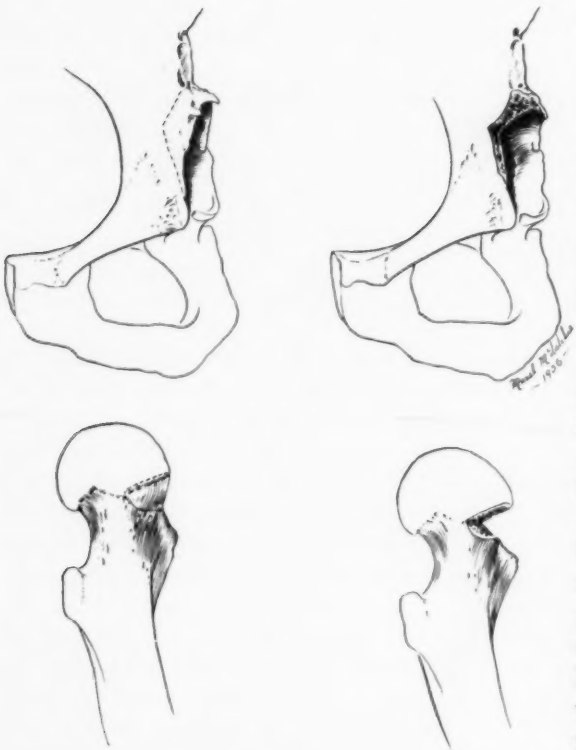

FIG. 1

Diagrams demonstrating the amount of bone which must be removed from the acetabulum or from the neck of the femur in order to produce the same improvement in the range of motion. This amount of bone may be easily spared from the acetabulum, but not from the neck of the femur.

as a housekeeper, free from pain and without a limp.

The success in this case naturally suggested that the same procedure might be successful in other types of cases in which similar impingement was present. Malum coxae senilis came to our minds first. Since the operation was one that did no harm, we felt justified in applying it to a condition for which we had no adequate treatment. It has now been performed in eight such cases and the response has been so favorable that we feel free to publish a description of the procedure, in spite of the fact that it has been used for too short a time to enable us to give "end results".

The procedure has also been applied to two cases of "old slipped upper femoral epiphysis" with impingement of the projecting anterior femoral neck on the anterior acetabular margin. In each case there has been improvement in function and relief from pain.

Fractures of the acetabulum with intrapelvic displacement of the head of the femur present the same mechanical problem as did the first case,—that of intrapelvic protrusion of the acetabulum. Consequently this operative procedure might be very effective in relieving pain and restoring function in this type of case.

OPERATIVE TECHNIQUE

The incision extends along the anterior third of the iliac crest to the anterior superior spine, then curves slightly medially along the lateral border of the sartorius muscle. (See Figure 2.) Immediately inferior to the anterior superior spine one finds the plane of division between the sartorius and the tensor fasciae femoris. The femoral fascia is incised

along the lateral border of the sartorius, exposing the direct head of the rectus femoris. By sharp and blunt dissection the attachment of the direct head of the rectus femoris to the anterior inferior spine is defined.

The next step (Fig. 3) is to identify the plane of division between the iliopsoas muscle and the proximal portion of the reflected head of the rectus femoris; the latter takes origin from the anterior acetabular wall as well as from the anterior capsule. The iliopsoas muscle is retracted mesially (Fig. 4), exposing the anterior intrapelvic wall of the acetabulum. In order to obtain a better exposure of the lateral portion of the acetabulum, the tendon of the direct head of the rectus femoris is divided, leaving sufficient tendon attached to the anterior inferior spine to allow for suture: When the distal portion of this muscle is retracted, the reflected head of the rectus comes into view, partly fused with the anterior capsule, partly attached to the anterior acetabular margin. This is dissected free and retracted laterally with the direct head of the rectus femoris.

By the procedures described sufficient exposure of the anterior acetabular wall is usually obtained, but in some cases the iliopsoas muscle remains too taut to be retracted. In these cases it is advisable to reflect subperiosteally the origin of the sartorius and the abdominal oblique muscle from the anterior crest of the ilium, exposing the anterior portion of the iliac fossa. The iliacus may then be reflected subperiosteally down to the upper margin of the anterior acetabular wall, but at this point the periosteum is divided along the line of the intended osteotomy.

The above procedures allow for retraction of the iliopsoas muscle and of the sartorius mesially, and of both the direct and the reflected heads of the rectus femoris, and of the tensor fasciae femoris laterally. If the retraction mesially of the iliopsoas muscle is found difficult, the hip may be flexed, adducted, and externally rotated; by this procedure, the iliopsoas becomes relaxed and consequently may be retracted more easily. (See Figure 5.)

The next step is the osteotomy of the anterior acetabular wall; this may be done with

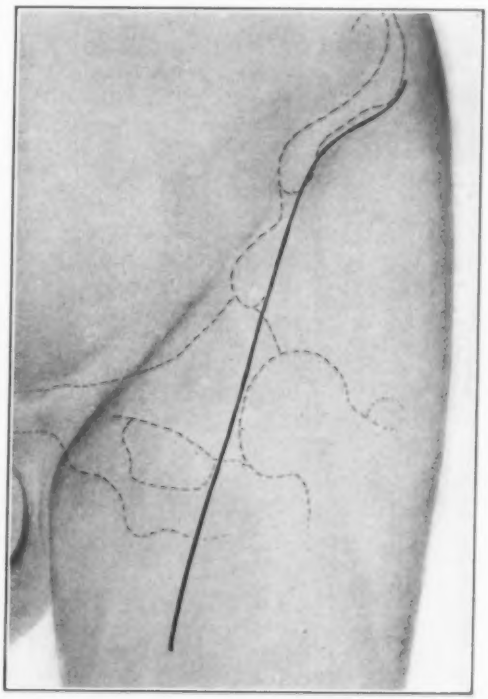

FIG. 2

The incision extends along the anterior third of the ilium and curves mesially along the lateral border of the sartorius.

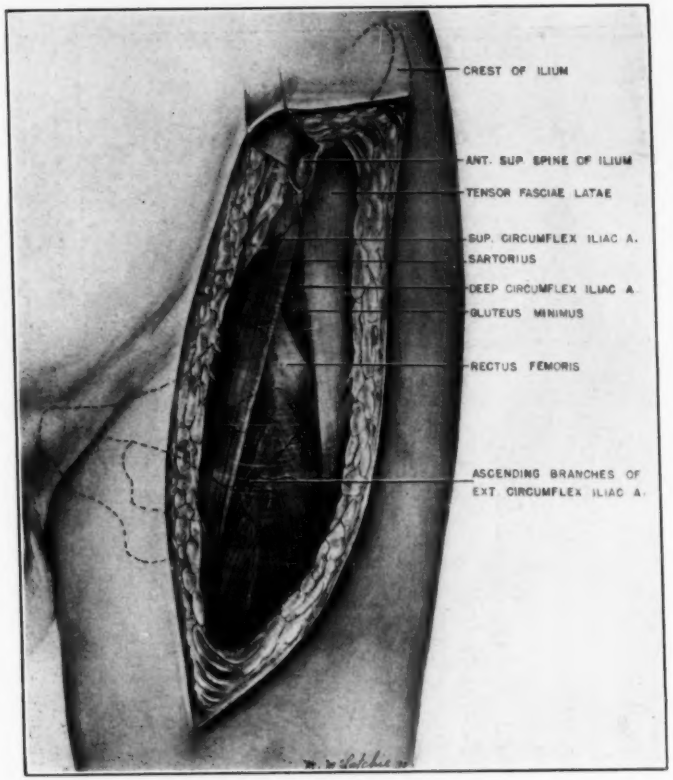

FIG. 3

Exposure of the anterior superior spine, of the lateral border of the sartorius, and of the mesial border of the tensor fasciae latae. Between these muscles is a compartment of fat with the rectus femoris as its floor.

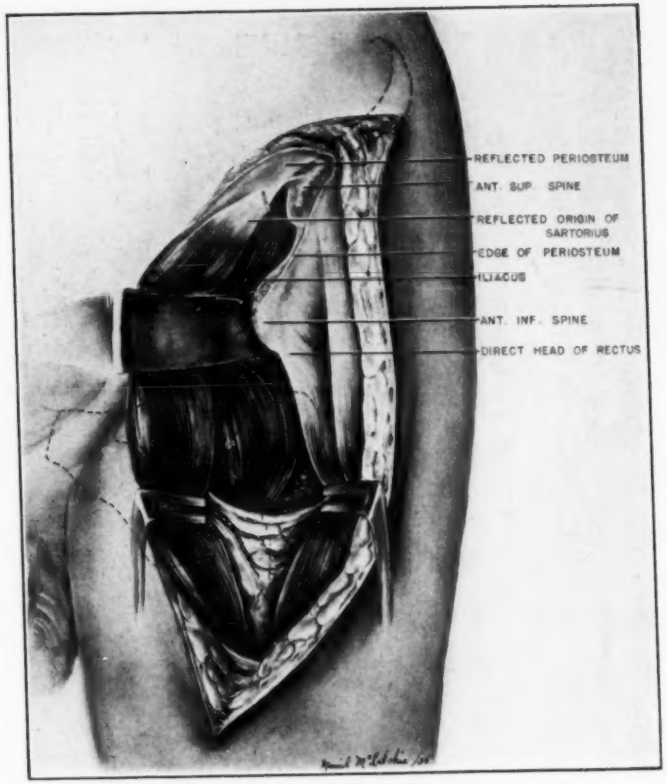

FIG. 4

Reflection of the abdominal oblique, sartorius, and iliopsoas muscles mesially, exposing the anterior aspect of the hip joint.

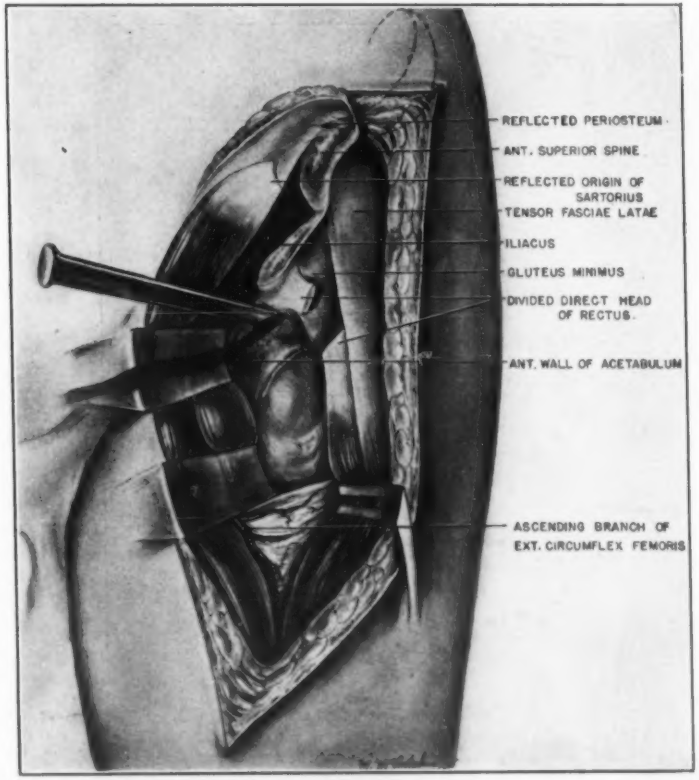

FIG. 5

Showing the line of osteotomy of the anterior acetabular wall immediately below the attachment of the direct head of the rectus femoris.

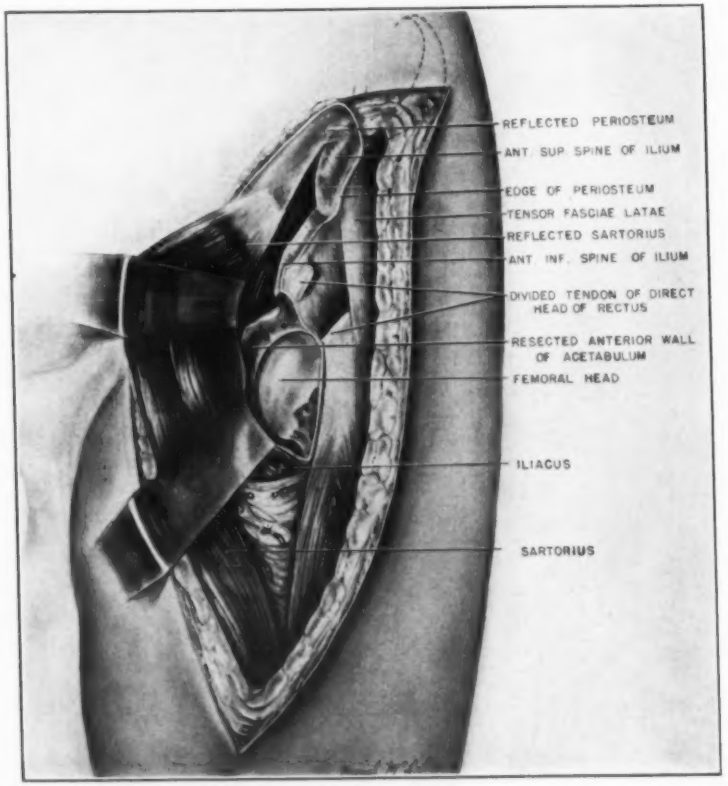

FIG. 6

Result of plastic procedure: exposure of the mesial portion of the femoral head and of the anterior femoral neck.

a thin osteotome or gouge. The osteotomy starts just below the attachment of the direct head of the rectus femoris and is carried mesially a distance of approximately an inch and a half and is then curved inferiorly down to the cotyloid notch. As soon as the fragment thus outlined becomes mobile the anterior superior capsule is incised down to the region of the distal neck. It is also incised inferiorly from the cotyloid notch along a line just proximal to the capsular attachment to the neck of the femur. (See Figure 6.) When the anterior acetabular wall with its attached capsule is lifted out, there is obtained a beautiful exposure of the articular surface of the head of the femur and of the anterior aspect of the neck.

By moving the hip in flexion, extension, abduction, and internal rotation, the surgeon now determines if the plastic procedure has been sufficient. If not, further excision of the superior acetabular margin and of the superior anterior capsule is done. The surgeon must be radical in performing this plastic procedure, but he should not remove so much of the superior aspect of the acetabulum as to allow the head of the femur to become displaced anteriorly. Of this there is relatively little danger, since hyperextension is rarely obtained and this is the motion which would allow the femoral head to dislocate.

The procedure follows structural planes throughout and consequently

FIG. 7

Preoperative roentgenogram showing definite protrusion of the acetabula, more marked on the left than on the right.

there is little or no shock. The two blood vessels encountered are the deep iliac circumflex and the ascending branch of the internal femoral circumflex. The former is easily eliminated; the latter sometimes gives rise to a little difficulty because of its extensive ramifications in the fat anterior and inferior to the hip joint. Furthermore, it is accompanied by motor branches from the femoral nerve.

FIG. 8

FIG. 9

FIG. 10

The closure of the wound is very simple indeed. When the retractors are removed the iliopsoas drops back into place over the anterior aspect of the head and neck of the femur. The direct apposition of the posterior surface of this muscle to the anterior aspect of the head and neck of the femur is of great advantage,—two moving surfaces are very much less liable to form adhesions to one another than are two surfaces in more or less constant apposition, such as would be true of the capsule and of the underlying joint surface. The direct head of the rectus is sutured to its origin, and the superficial portion of the wound is closed in layers.

Postoperative convalescence is remarkable because of the relative absence of pain. The patient complains of soreness, but rarely of acute pain. The extremity is suspended with five pounds of traction, simply to overcome muscle spasm and thereby to diminish pain. The position should be one of extension with maximum abduction and maximum internal rotation. At the end of two weeks the patient is allowed up on crutches and, as a rule, he leaves the hospital at the end of three weeks; the maximum period of hospitalization is four weeks. He is taught exercises which he thoroughly understands by the time he leaves the hospital and which he carries on at home.

As already stated the main effect of this procedure is relief from pain; however, there is also considerable improvement in function. The in-

FIG. 11

Preoperative roentgenogram showing proliferative changes with thinning of the joint cartilage.

creased function is the direct result of the removal of the acetabular wall, thus preventing impingement. If the anterior femoral head and neck are very prominent, it may at times be advisable to do a plastic operation on these as well as on the acetabulum. There is no danger of new bone formation or exostoses as a result of this procedure, since mechanical interference has been eliminated and since medullary bone is in apposition to the moving posterior surface of the iliopsoas muscle. The removal of the anterior capsule is probably an important factor in eliminating pain, because of its sensory innervation. It is important to remove sufficient capsule, including the Y ligament of Bigelow, to diminish the chances of adhesions and of scar formation. Another point to be emphasized in the technique is this: The acetabular wall should not be exposed subperiosteally, but its periosteum should be removed with it. This will tend to prevent new bone formation.

FIG. 12

Postoperative roentgenogram. The line of osteotomy of the acetabulum is indicated by arrows.

In one case the iliopsoas bursa was encountered. It was distended and inflamed, and unquestionably had been a source of pain.

FIG. 13

CASE REPORTS

FIG. 14

The first case treated by this operative method was a case of "bilateral intrapelvic protrusion of the acetabulum" (Fig. 7). The patient was a woman, fifty-five years of age, who for months had been disabled for her occupation as a housekeeper. She was in pain lying in bed, sitting, standing, and walking. As a result of the operation she was able to return to work, free from pain and without even a limp. The postoperative range of motion was definitely but not markedly increased. Figure 7 shows very definite protrusion of the acetabulum on the left and the same condition, but to a lesser extent, on the right. The postoperative roentgenogram shows no essential change. Ten months after the operation function was as follows: complete extension (Fig. 8), flexion to 90 degrees (Fig. 9), and a perfectly definite amount of abduction (Fig. 10).

As has been stated in the introduction, the success in the above case led us to apply it to cases of malum coxae senilis.

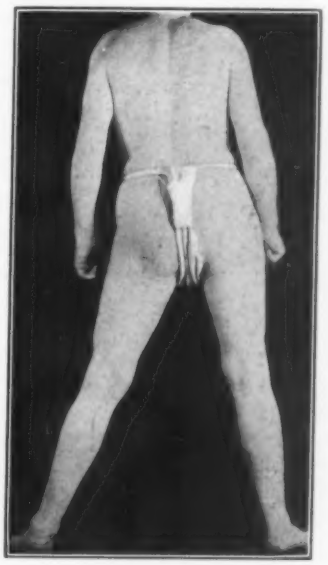

FIG. 15

The first case was a man of fifty-eight, whose occupation was that of a brakeman. He had had symptoms from the right hip for a period of years and had been disabled for several months. Roentgenographic examination (Figs. 11 and 12) showed changes in both hips,—hypertrophic changes and thinning of the joint cartilage, more marked on the right than on the left. Postoperatively the patient never at any time complained of pain. He was allowed up on crutches in seventeen days and was discharged on the twenty-fifth day. At the time of discharge he got about very well indeed and was able to put on his right shoe for the first time in years. In five months he returned to his former occupation, which required jumping on and off trains. He was allowed to do this by promising that he would not jump on his right foot. When last seen, eight months after the operation, he had been back at work for three months; he complained of no pain and walked with a scarcely noticeable limp. Figures 13, 14, and 15 show this patient's function at this time. There was permanent flexion of 20

FIG. 16

Preoperative roentgenogram showing hypertrophic changes with thinning of the joint cartilage.

degrees, motion in flexion to a good 90 degrees, and very little abduction (it was estimated as 10 to 15 degrees).

This case is important because the patient had two more years to go before he could obtain a pension. If it is proved that this procedure does not give permanent relief, it may at least be useful in producing temporary relief and improved function over an important period of time.

The second case was a blacksmith, fifty-eight years old. He had been in constant pain for several months before admission to the hospital. According to his story, he was unable to lie, sit, stand, or walk without pain. Figure 16 shows the condition before operation. The same procedure was performed. (See Figure 17.) In the course of five months the patient returned to his blacksmith shop to do a couple of hours' work a day. At the end of nine months he worked all day when he could find the work to do. Even at the time when this report was written, ten months after the operation, he walked with a very distinct limp, but this limp was unaccompanied by pain. He was comfortable lying, sitting, standing, and walking. Function at the end of nine months was as follows: 30 degrees of permanent flexion, motion in flexion to a good 90 degrees, abduction of approximately 10 degrees (Figs. 18, 19, and 20).

FIG. 17

Postoperative roentgenogram. Not much change is demonstrable.

Eleven cases have been treated by this method,—eight of "malum coxae senilis", two of "old slipped femoral epiphysis", and one of "intrapelvic protrusion of

the acetabulum". They have all done well; the relief from pain is the outstanding feature; gain in motion is definite but not marked. Most of the patients still have a perfectly definite, noticeable limp.

FIG. 18

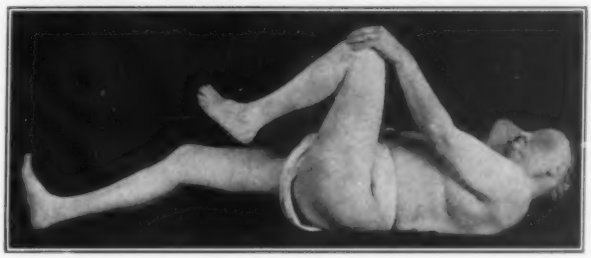

FIG. 19

POSTOPERATIVE TREATMENT

The outstanding feature of the postoperative period is the slight amount of pain complained of; some patients state that they have no "pain" at all, others say they have "soreness", but none complain of acute pain.

The affected extremity is suspended with five pounds of traction in the optimum position,—maximum abduction and internal rotation, minimum flexion.

Following two weeks of recumbency the patient is gradually allowed to sit up and is trained to use crutches. The period of hospitalization should be a minimum of three weeks, a maximum of four. When the patient leaves the hospital he should be thoroughly trained in exercises to maintain the corrected position.

FIG. 20

COMMENTS

In the cases so far operated upon, the author's attention has been directed chiefly to the anterior acetabular wall and to the anterior capsule of the hip joint. (See Figure 21.) In some cases a plastic procedure has been performed on the anterior femoral head and neck, when they have been the seat of advanced proliferative changes. The inferior portion of the head and neck has likewise been removed for the same reason; this has been done in two cases only. The posterior aspect of the head and neck has been left untouched. This may be one reason why a greater improvement

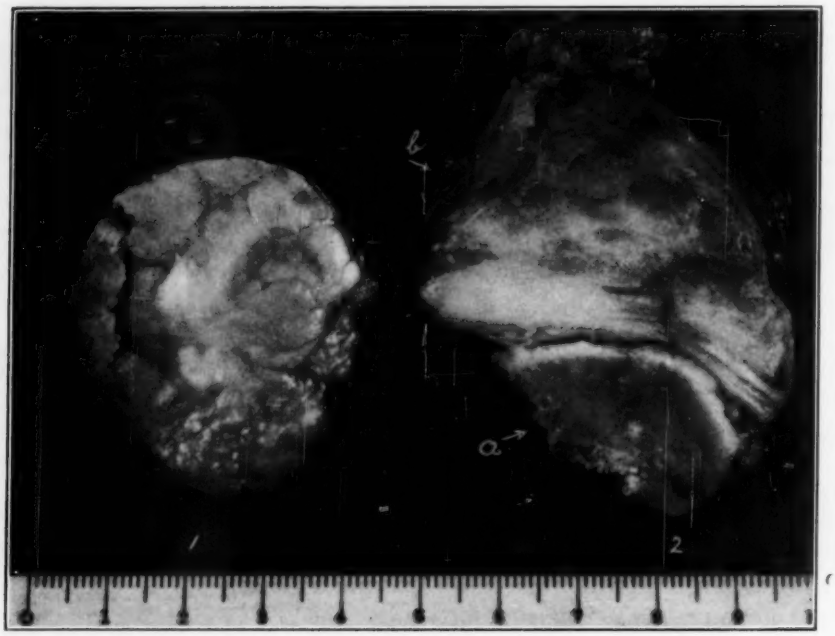

FIG. 21

Characteristic appearance of specimen removed, consisting of: *a*, acetabular wall; *b*, attached capsule. *1* shows the specimen as viewed from the outside; *2* shows the intra-articular synovial surface.

in range of motion has not been obtained. The writer considers it unwise to attack this region.

Gentle manipulation for the sake of increasing the range of motion has been carried out in some of the cases at the end of the operative procedure. It is the author's feeling that this is distinctly worth while and should be done routinely.

SUMMARY

A plastic procedure has been proposed for the relief of hip-joint conditions resulting from interference with the normal mechanics of the hip joint. Such conditions are "malum coxae senilis", "intrapelvic protrusion of the acetabulum", "old slipped upper femoral epiphysis", "fractures of the neck of the femur with malposition", "Legg-Calvé-Perthes disease", and "fractures of the acetabulum".

Sufficient time has not elapsed to obtain true end results, but the author feels justified in rendering this preliminary report because the method is non-destructive and seems effective in relieving pain in conditions for which there is no other adequate treatment.

ARTHROPLASTY OF THE KNEE JOINT

BY J. ED. SAMSON, M.D., MONTREAL, CANADA

During the last twenty-five years arthroplasty has frequently been practised by orthopaedic surgeons of all countries. Ollier of Lyon, Murphy of Chicago, Putti of Bologna, and MacAusland of Boston have been the pioneers in performing this operation.

Up to 1935 * the author performed thirty-seven arthroplasties for ankylosis of the knee joint. Of these thirty-seven patients, twenty-four were female and thirteen were male. Their ages ranged from eighteen to fifty-four years. These cases may be classified as follows:

Nature of Ankylosis	*No. of Cases*
Gonococcus	15
Trauma	3
Osteomyelitis	1
Tuberculosis	2
Staphylococcus septicaemia	5
Hypertrophic osteo-arthritis	7
Surgical infection of knee	3
Congenital deformity	1
Total	37

The author refuses to operate on patients under eighteen years of age on account of the risk of traumatizing the epiphyseal line. Experience has shown that the best results are obtained in patients ranging in age from twenty to forty years. The patients are always informed that the postoperative treatment will be painful and of long duration, and that their complete cooperation is necessary to obtain a good result.

Various writers claim that bony ankylosis usually gives better results than fibrous ankylosis, but the author has obtained about the same results from both types of ankylosis.

All acute symptoms should have ceased at least one year before the operation. The limb operated on should have good, strong muscles and be about the same length as the other one.

Some claim that arthroplasty gives an unstable, painful and motionless joint, but all experienced orthopaedic surgeons who have frequently performed that operation know that these accusations are false; on the contrary, the new joint allows fully 90 degrees of flexion and gives a very stable and supple knee. Some of the writer's patients were operated on ten years ago and they have been walking and working ever since, with the greatest ease and without any discomfort.

The author always uses a free flap of fascia lata as a transplant.

* During 1935 eleven more arthroplasties for ankylosis of the knee joint were performed by the author.

TABLE I

ANALYSIS OF THIRTY-SEVEN ARTHROPLASTIES FOR ANKYLOSIS OF THE KNEE JOINT

Case	Sex	Age (*Years*)	Nature of Ankylosis	Side	Duration
1. M. H.	Female	20	Acute suppurative arthritis	Right	10 months
2. L. B.	Male	39	Gonorrhoeal arthritis	Right	1 year
3. C. L.	Female	20	Septicaemic arthritis	Right	5½ years
4. D. F.	Female	24	Gonorrhoeal arthritis	Left	14 months
5. L. O.	Female	17	Tuberculous arthritis	Left	5 years
6. J. D.	Female	38	Gonorrhoeal arthritis	Left	2 years
7. F. M.	Female	22	Gonorrhoeal arthritis	Right	1 year
8. O. L.	Male	36	Tuberculous arthritis	Right	28 years
9. C. V.	Female	43	Gonorrhoeal arthritis	Right	14 months
10. W. B.	Female	54	Chronic arthritis	Bilateral	9 years
11. J. D.	Male	24	Gonorrhoeal arthritis	Right	2 years
12. E. T.	Female	31	Gonorrhoeal arthritis	Bilateral	18 months
13. J. L.	Female	18	Acute osteomyelitis of the femur	Right	11 years
14. E. B.	Female	22	Gonorrhoeal arthritis	Right	1 year
15. A. D.	Male	54	Fracture of the tibia	Right	2 years
16. A. B.	Male	19	Infected wound	Left	2 years
17. L. G.	Female	25	Gonorrhoeal arthritis	Left	3 years
18. J. E. P.	Female	38	Gonorrhoeal arthritis	Right	2 years
19. A. F.	Male	35	Chronic osteo-arthritis	Right	2 years
20. M. A. P.	Female	29	Gonorrhoeal arthritis	Right	2 years
21. E. C.	Male	18	Traumatic arthritis	Left	13 months
22. R. L.	Female	36	Gonorrhoeal arthritis	Left	18 months
23. S. C.	Female	22	Osteomyelitis of the femur	Left	3 years
24. D. G.	Female	27	Gonorrhoeal arthritis	Left	1 year
25. L. L.	Female	26	Congenital deformity of the femur	Left	Congenital
26. E. M.	Male	25	Undetermined	Right	2 years
27. C. L.	Female	24	Gonorrhoeal arthritis	Right	2 years
28. E. C.	Male	46	Chronic osteo-arthritis	Left	6 years
29. F. G.	Female	22	Suppurative arthritis	Right	3 years
30. S. M. E.	Female	52	Ankylosed chronic arthritis	Right	18 years
31. E. R.	Male	44	Traumatic arthritis	Left	6 years
32. E. L.	Female	48	Ankylosed chronic arthritis	Right	5 years
33. P. L.	Female	21	Suppurative arthritis	Right	10 years
34. M. M.	Male	19	Suppurative arthritis	Right	2 years
35. H. D.	Male	34	Traumatic arthritis	Left	2 years
36. Y. H.	Male	38	Gonorrhoeal arthritis	Right	14 months
37. A. C.	Male	54	Chronic hypertrophic osteo-arthritis	Left	6 years

TABLE I (*Continued*)

Case	Date of Admission	Date of Arthroplasty	Mobilization under Anaesthesia	Duration of Physical Therapy
1. M. H.	Nov. 5, 1925	Nov. 8, 1925	Jan. 10, 1926	1 year
2. L. B.	Sept. 4, 1928	Sept. 8, 1928	Nov. 17, 1928	6 months
3. C. L.	Oct. 15, 1928	Oct. 31, 1928	Jan. 7, 1929	6 months
4. D. F.	Feb. 26, 1932	March 2, 1932	None	None
5. L. O.	May 28, 1926	June 6, 1926	None	None
6. J. D.	Nov. 5, 1926	Nov. 10, 1926	None	2 months
7. F. M.	May 28, 1927	June 3, 1927	Nov. 4, 1927	None
8. O. L.	Sept. 6, 1933	Sept. 13, 1933	Jan. 3, 1934	1 month
9. C. V.	Jan. 27, 1930	Jan. 30, 1930	None	4 months
10. W. B.	June 8, 1934	June 20, 1934 (left)	None	None
11. J. D.	May 18, 1933	June 1, 1933	Sept. 13, 1933	None
12. E. T.	June 9, 1932	June 14, 1932 (left)	Aug. 24, 1932	None
		Sept. 1, 1933 (right)	None	None
13. J. L.	May 18, 1927	June 8, 1927	None	None
14. E. B.	Jan. 10, 1934	Feb. 8, 1934	April 20, 1934	5 weeks
15. A. D.	Jan. 3, 1933	Jan. 7, 1933	March 10, 1933	1 month
16. A. B.	March 16, 1933	March 20, 1933	June 18, 1933	None
17. L. G.	June 1, 1934	June 5, 1934	None	None
18. J. E. P.	Aug. 3, 1934	Aug. 8, 1934	None	None
19. A. F.	Nov. 26, 1933	Nov. 30, 1933	Feb. 16, 1934	None
20. M. A. P.	Sept. 14, 1928	Sept. 20, 1928	None	None
21. E. C.	July 19, 1927	July 28, 1927	Sept. 2, 1927	2½ months
			Oct. 3, 1927	
22. R. L.	July 1, 1932	July 4, 1932	None	None
23. S. C.	April 4, 1932	April 9, 1932	None	None
24. D. G.	March 13, 1932	March 17, 1932	None	None
25. L. L.	Oct. 4, 1933	Oct. 10, 1933	Jan. 12, 1934	None
26. E. M.	Aug. 1, 1933	Aug. 5, 1933	None	None
27. C. L.	Feb. 14, 1934	Feb. 17, 1934	April 20, 1934	None
28. E. C.	June 18, 1928	June 22, 1928	July 15, 1928	None
29. F. G.	June 25, 1928	June 30, 1928	Aug. 20, 1928	None
30. S. M. E.	April 20, 1930	April 26, 1930	June 15, 1930	None
31. E. R.	March 4, 1931	March 7, 1931	May 8, 1931	None
32. E. L.	June 3, 1933	June 8, 1933	July 30, 1933	None
33. P. L.	Feb. 1, 1928	Feb. 4, 1928	March 6, 1928	1½ months
34. M. M.	Sept. 1, 1934	Sept. 5, 1934	Nov. 5, 1934	None
35. H. D.	Nov. 20, 1934	Nov. 29, 1934	Jan. 20, 1935	None
36. Y. H.	Oct. 19, 1934	Oct. 23, 1934	Jan. 10, 1935	1 year
37. A. C.	Aug. 2, 1927	Aug. 5, 1927	None	6 months

TABLE I (*Continued*)

Case	Condition on Discharge			Final Result and Postoperative Period
	Degree of Flexion	Degree of Extension	Stability of the Joint	
1. M. H.	150 degrees	Complete	Good	Good, 1 year
2. L. B.	60 degrees	Complete	Good	Good, 6 months
3. C. L.	90 degrees	Complete	Good	Good, 6 months
4. D. F.	80 degrees	Complete	Good	Good, 3 months
5. L. O.	60 degrees	Complete	Poor	Poor, 1 year
6. J. D.	60 degrees	Complete	Good	Good, 4 months
7. F. M.	90 degrees	Complete	Good	Good, 4 months
8. O. L.	90 degrees	Complete	Good	Good, 5 months
9. C. V.	90 degrees	Complete	Good	Good, 6 months
10. W. B.	60 degrees	Complete	Good	Good, 7 months
11. J. D.	90 degrees	Complete	Good	Good, 1 year
12. E. T.	90 degrees	Complete	Good	Good, 5 months
	None	Complete	Good	Ankylosis in extension, 3 months
13. J. L.	None	Complete	Good	Ankylosis in extension, 4 months
14. E. B.	70 degrees	Complete	Good	Good, 8 months
15. A. D.	90 degrees	Complete	Good	Good, 5 months
16. A. B.	80 degrees	Complete	Good	Good, 4 months
17. L. G.	70 degrees	Complete	Good	Good, 5 months
18. J. E. P.	70 degrees	Complete	Good	Good, 3 months
19. A. F.	60 degrees	Complete	Good	Good, 6 months
20. M. A. P.	40 degrees	Complete	Good	Good, 5 months
21. E. C.	80 degrees	Complete	Good	Good, 6 months
22. R. L.	20 degrees	Complete	Good	Good, 3 months
23. S. C.	None	Complete	Good	Ankylosis in complete extension, 1 year
24. D. G.	90 degrees	Complete	Good	Very good, 4 months
25. L. L.	70 degrees	Complete	Good	Very good, 6 months
26. E. M.	90 degrees	Complete	Good	Very good, 6 months
27. C. L.	15 degrees	Complete	Good	Satisfactory, 6 months
28. E. C.	40 degrees	Complete	Good	Good, 4 months
29. F. G.	35 degrees	Complete	Good	Good, 6 months
30. S. M. E.	70 degrees	Complete	Good	Good, 5 months
31. E. R.	80 degrees	Complete	Good	Good, 4 months
32. E. L.	60 degrees	Complete	Good	Good, 4 months
33. P. L.	45 degrees	Complete	Good	Good, 7 months
34. M. M.	15 degrees	Complete	Good	Satisfactory, 6 months
35. H. D.	40 degrees	Complete	Good	Good, 3 months
36. Y. H.	60 degrees	Complete	Good	Good, 1 year
37. A. C.	70 degrees	Complete	Good	Good, 6 months

FIG. 1

Case 1. Before operation. Complete fusion of the femur with the tibia.

FIG. 2

Case 1. Four years after operation. Good space between the femur and the tibia. New articular cartilage may be seen on the tibia.

This membrane disappears after a while, to be replaced by a flattened fibrous tissue which contains true cartilage. The writer had occasion to reopen two knees upon which he had previously performed arthroplasties, and it was possible to verify the disappearance of the flap and the presence of a new chondroid covering of the articular surfaces.

In the first case, operated upon five years before, the articular space was about normal and the articular surfaces were hard, regular, and smooth. The capsule and lateral ligaments were tight and prevented lateral mobility. Crucial ligaments or fibrous bands which could replace them were not found. Some authors have attributed the great stability of the new joint to the production of fibrous bands which may replace the crucial ligaments. In this case the crucial ligaments were absent; the knee, however, was very stable in extension and in flexion. Before her last accident (fracture of the internal tibial condyle, after a fall), the patient could put all her weight on this limb, flexed to its limit, without any help whatever and she could raise herself easily.

In the second case, seven months after operation, a dense and abundant fibrous tissue covered the new tibial tendon and prevented its articulation with the condylar notch. The femoral and tibial articular surfaces were clothed with this fibrous and flattened tissue which allowed a good

deal of flexion. The excision of this exuberant scar tissue over the tibial tendon allowed complete extension.

Ankylosis of one knee in slight flexion or full extension is compatible with an ordinary normal life. Many people will accept it without any recrimination, while others will never resign themselves to having a stiff knee and will be ready to do anything to get back mobility in the joint. Ankylosis should always be respected when it is caused by a tuberculous or by an osteomyelitic infection. However, fusion of both knees or of both hips, or of one knee and of one hip, urges the surgeon to restore mobility to at least one of these joints to allow the patient the advantage of sitting and walking alone.

In a word, arthroplasty is questionable in a case of ankylosis of one knee; it is always recommended when more than one joint of the lower extremity is fused.

OPERATIVE TECHNIQUE

Various techniques, with more or less important modifications, have

FIG. 3

Case 2. Before operation. Destruction of the internal tibiofemoral articular surfaces. Fibrous tibiofemoral ankylosis.

FIG. 4

Case 2. Eight months after operation. The articular space is wide, and the tibial tendon is visible in the enlarged intercondylar opening.

FIG. 5

Case 3. Before operation. Bony tibiofemoral ankylosis.

FIG. 6

Case 3. Seven years after operation. The articular space is good. The patella is lengthened and is separated from the femur and from the tibia by a good space. The articular cartilage is dense and very regular.

been employed by surgeons. The following method has been employed in all of the author's cases.

The incision on the internal aspect of the knee is used and the usual Putti technique is employed, with the exception that the writer always constructs in the center of the tibia a tendon which, when once introduced in the intercondylar groove especially built for this purpose, prevents lateral displacement of the femur on the tibia. The tourniquet is removed only when the cast is dry and fits the knee well. For the last four years traction on the limb after the operation has been omitted. The cast is left in place about ten days; then, if the wounds are healed, massage and passive mobilization are employed every day for ten minutes. Active mobilization is permitted about the twentieth day after the operation; walking on the limb with the help of crutches is allowed at the end of one month. The patient is encouraged to put some weight on the limb and to use the quadriceps as much as he can to get active motion in the knee and also to make the new surfaces rub against each other.

With the exception of gentle massage, mobilization, and mecanotherapy, which are of great help to the patient, the writer has given up physiotherapy almost entirely. In ten of the arthroplastic cases only massage and mobilization were employed, while in the others diathermy,

infra-red rays, and galvanic and faradic treatments were given. The findings were compared and no difference was found either in the length of time of the postoperative treatment or in the final results. In nearly all cases a careful mobilization under anaesthesia was done about six weeks after the operation. This method allows free motion of the joint and gives confidence to the patient, who often becomes tired of working without "visible" results and who always gives better cooperation after he has attained a good degree of mobility in the joint. Careful mobilization is harmless.

Cases 1 and 2 are typical and are reported in detail. The entire thirty-seven cases are summarized in Table I.

FIG. 7

Case 8. Before operation. Bony ankylosis of the knee in flexion of 145 degrees. The condyles are deformed and present the aspect of a large bony mass, lengthening toward the back and forming an angle of 45 degrees with the axis of the femur.

CASE 1. M. H., a female, twenty years of age, was seen on August 6, 1924. The patient gave a history of acute suppurative arthritis of traumatic origin. On November 10, 1923, she had stuck a needle into the right knee. The needle had broken and part of it had remained in the joint. A bilateral arthrotomy had been done on November 16, 1923. The suppuration lasted until January 20, 1924. During this period, the limb had been immobilized in a splint. The patient had begun to walk without crutches on March 15, 1924. There had been no movement in the knee joint since the accident.

Physical examination showed a healthy adult, five feet, six inches in height, weighing 129 pounds. There was ankylosis of the right knee in full extension. Scars on the lateral portion of the knee indicated the site of drainage. There was no sign of activity in the joint. The quadriceps was slightly atrophied. The patella, femur, and tibia were fused, as seen in Figure 1.

On November 8, 1925, an arthroplasty was performed. The limb was immobilized in a cast for twelve days, following which traction was applied for ten days. Passive mobilization and massage were employed daily after the twelfth day, and active movements were allowed on December 15, 1925.

Examination, on January 9, 1926, showed complete extension and passive flexion of 50 degrees. Later, mobilization, under anaesthesia, resulted in flexion of 90 degrees. The knee was then immobilized in extension for two days, after which passive motion and massage were begun and continued daily.

The patient walked with two crutches until April 10, 1926. At this time there was flexion of 60 degrees and complete extension. The patient left the hospital using only one cane.

On October 29, 1927, examination showed complete extension and flexion of 110 degrees. The knee was stable and the gait was normal. Figure 2 shows the regularity of the contours of the new joint.

The patient has led a normal life since 1927 and has studied to be a nurse. When she was last seen in July 1933, examination revealed practically normal flexion, complete extension, no lateral mobility, and painless movements.

CASE 2. L. B., a male, thirty-nine years old, was seen on May 16, 1928. The patient gave a history of ankylosis of the right knee, after vaccine and cast treatment, following a gonorrhoeal arthritis in June 1927.

Physical examination showed a healthy adult, five feet, five inches in height, weighing 140 pounds. The right knee was ankylosed in full extension (Fig. 3) and showed no evidence of activity.

On September 8, 1928, an arthroplasty was performed. A cast, combined with traction, was left in place for ten days. After the removal of the cast, traction was continued for twelve days. Passive movements were made up to November 17, 1928.

Examination, on November 17, 1928, showed complete extension and a range of 30 degrees of passive flexion.

FIG. 8

Case 8. Fifteen months after operation. The articular space is good. The tibia and the femur are in good alignment.

On November 17, 1928, mobilization, under anaesthesia, resulted in flexion of 90 degrees, followed by physiotherapy, diathermy, galvanic current, and massage for a period of six months.

Examination, on May 5, 1929, showed complete extension and flexion of 60 degrees. The movements were free from spasm and pain. Figure 4 shows the shape of the new joint.

The patient has not been examined since that date, but it is known that he is walking well.

With the exception of three cases, arthroplasty of the knee gave a good functional result in each case.

FIG. 9

Case 11. Before operation. Ankylosis of the knee. Increase in volume of the posterior aspect of the condyles, giving them a flat appearance.

FIG. 10

Case 11. Twenty-one months after operation. The articular space is good. The tibial tendon adapts itself well to the intercondylar opening.

FIG. 11-A

FIG. 11-B

Case 11. Twenty-one months after operation. There is complete extension of the knee and flexion to 90 degrees.

FIG 12

Case 14. Before operation. Lessening of the articular space of the knee and ossification of the crucial ligaments.

FIG. 13

Case 14. Four months after operation. Good articular space and satisfactory tibiofemoral contact. The tibial tendon is in good contact with the intercondylar opening.

In the first case, ankylosis recurred because the patient refused to mobilize the joint. In the second, the knee was again ankylosed following osteomyelitis. In the third (tuberculosis followed by ankylosis) the joint allowed movement without activity of the tuberculous lesion, which resulted in the loss of stability of the joint.

Mobilization under anaesthesia has been of great help in the post-operative treatment.

LOCALIZED HYPERTROPHIC CHANGES IN THE CERVICAL SPINE WITH COMPRESSION OF THE SPINAL CORD OR OF ITS ROOTS *

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The commonest pathological finding observed in the roentgenographic examination of the spine in people over middle life is the so called "hypertrophic arthritis" of the vertebral bodies. It is a striking fact, however, that, while these familiar hypertrophic changes are seen very commonly on the arterior and lateral aspects of the body, it is rare to find them on its posterior aspect. The reason for this is not entirely clear, but, according to Beadle, the fibers of the posterior longitudinal ligaments have a very sparse attachment to the bone and are joined to the posterior ends of the intervertebral discs, while the anterior longitudinal ligament is attached more directly to the bone, which apparently leads to the formation of osteophytes on the anterior aspect of the vertebral body.

Some writers [9] on vertebral diseases comment on the absence of osteophytes coming from the posterior aspect of the bodies, but there are a few reports scattered throughout the literature of cases in which symptoms have apparently resulted from such a condition.[1, 3, 4, 6, 7, 8]

Schmorl has described little herniations of the nucleus pulposus which now go by the name of "Schmorl's nodes". These usually push into the substance of the bodies of the vertebrae through their upper or lower surfaces, but they may project posteriorly into the spinal canal. There are cases described in which symptoms have been caused by pressure on the cord from these nodes. Posterior projecting hypertrophic spurs must be distinguished from Schmorl's nodes in this position. These nodes are not visible in the roentgenograms unless they are calcified, while, of course, the hypertrophic bone changes are easily seen.

It has been pointed out by Hubeny that hypertrophic changes about the lateral aspects of the vertebral bodies may so diminish in size the canals for the spinal nerves that symptoms of "radiculitis" develop. The author believes that this takes place more commonly than is generally believed.

Owing to the anatomical arrangement of the cervical spine, hypertrophic changes in this area are more liable to encroach on a nerve canal than in the dorsal or lumbar areas. The usual anteroposterior and lateral roentgenograms of the spine fail to show the nerve canals and should be supplemented by oblique views if the examination is to be complete. One can be suspicious of involvement in the region of the nerve canals if

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 18, 1936.

FIG. 1

Lateral view of the cervical spine, showing osteophytes projecting into the cervical canal opposite the interspace between the fifth and sixth cervical vertebrae.

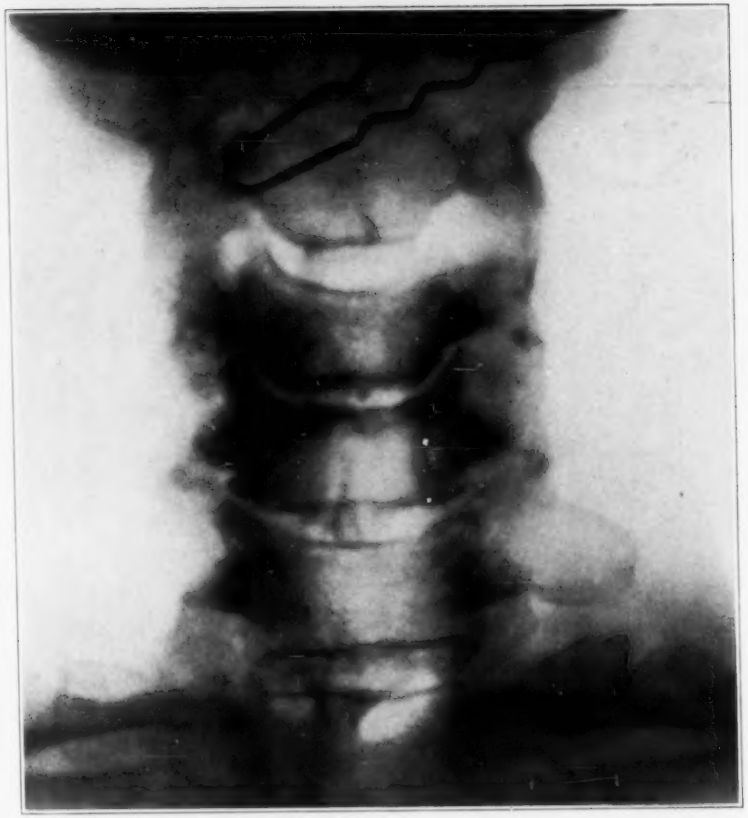

FIG. 2

Anteroposterior view of cervical spine, showing on the right side a hypertrophic thickening of the lateral portion of the upper surface of the sixth cervical vertebra.

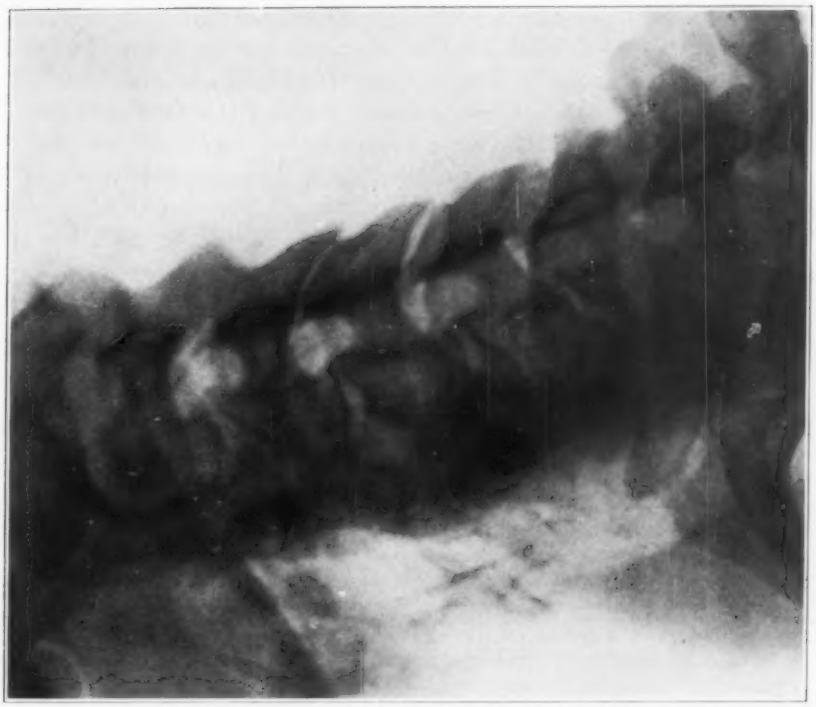

FIG. 4

An oblique roentgenogram of the same case as seen in Figs. 1, 2, and 3, showing normal nerve canals on the other side.

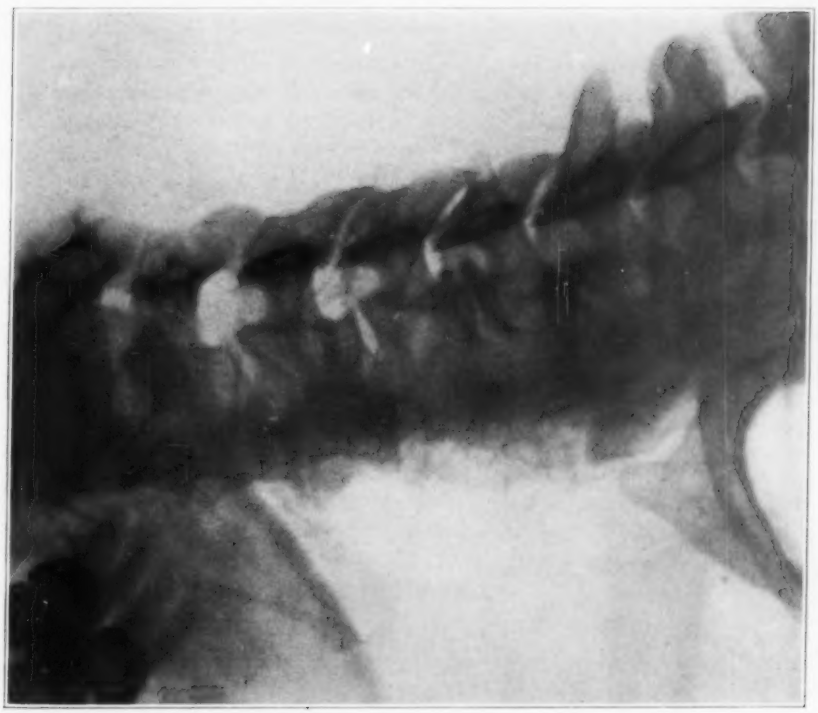

FIG. 3

Right oblique view, showing a marked projection into the nerve canal for the sixth cervical nerve.

one sees in the anteroposterior roentgenogram a hypertrophic thickening of the concave lateral portion of the upper surface of the vertebral body. When this is seen, oblique roentgenograms should be taken.

In two of the cases which follow, arthritic changes were demonstrated in the roentgenograms about the nerve canals, as well as on the posterior aspects of the vertebral bodies; in the third case, the latter finding alone was present.

CASE REPORTS

CASE 1. A man, aged fifty-seven, a professional athlete, was admitted to the hospital for study. His presenting symptom was numbness and tingling in the extremities. He had uncertainty in walking and girdle sensations about the abdomen. The symptoms were more pronounced on hyperextension of the cervical spine. The knee jerks were very active and the vibratory sense was lost at the ankles. There was a positive Babinski reflex on the right and considerable awkwardness in the use of the fingers in carrying out finer movements.

Spinal puncture showed evidence of a subarachnoid block, but when the head was extended to where numbness was felt in the fingers there was evidence of complete block.

Roentgenograms of the cervical spine showed a "very marked hypertrophic arthritis with the projection of a hypertrophic process posteriorly into the vertebral canal opposite the discs between the fourth and fifth cervical vertebrae". In addition to this, there were some hypertrophic changes on the lateral aspects of the bodies leading to diminution in the size of the nerve canals. There was some atrophy of the neck and shoulder muscles on the right side. Laminectomy was performed. A very definite projection, looking very much like a date pit laid transversely, was found extending across the anterior part of the spinal canal at the level previously mentioned. This was not removed. There has been considerable improvement since the operation, which was two years ago.

CASE 2. A woman, aged sixty, a housewife, was sent for a roentgenographic examination to rule out a cervical rib. She complained of pain and abnormal sensations in both arms, particularly in the right, and about the back of the neck. In the right hand the pain was limited to the radial and median nerve areas. Roentgenographic examination revealed a very definite marked projection of hypertrophic processes posteriorly into the spinal canal. This was present only opposite the interspace between the fifth and sixth cervical vertebrae. The rest of the spine was relatively free from arthritic changes except that there were considerable hypertrophic changes about the lateral portions of the fifth and sixth vertebral bodies on the right side, which encroached on the nerve canal for the sixth cervical nerve on the right side.

CASE 3. A woman, aged fifty-five, a housewife who always did very heavy work, came complaining of pain in the right arm and hand. The cervical spine was examined roentgenographically as a matter of routine and posterior projecting hypertrophic processes were found opposite the space between the fourth and fifth and the sixth and seventh cervical bodies. There were no arthritic changes about the other joints of these vertebrae and no encroachment of the nerve canal. No definite neurological signs were demonstrable. The patient experienced little if any relief from wearing a collar.

COMMENT

The purpose of this communication is to emphasize the occurrence of localized areas of hypertrophic change in the cervical spine, which may occur in such a position as to exert pressure on important nerves.

There seems no doubt that these hypertrophic processes can extend into the spinal canal and can press on the cord.

To show these changes most satisfactorily, lateral roentgenograms should be taken in the upright position at a six-foot distance. If the symptoms or the anteroposterior roentgenograms suggest involvement of the cervical nerves as they pass through the nerve canals, oblique roentgenograms should be taken. In interpreting oblique roentgenograms of the cervical spine, it should be remembered that the size of these cervical-nerve canals is not constant,—they are larger above and diminish in size as they descend. The smallest ones are those for the sixth and seventh cervical nerves.

These cases are evidently not common, but they do occur, and, in cases of obscure pain in the neck or in the arm, the possibility of pressure on the cord or nerves by osteophytes has to be kept in mind. The author has seen two patients who were sent to him with a provisional diagnosis of a cervical rib and who showed definite impairment in the size of the nerve canals, and two others who had posterior projecting osteophytes.

All the cases that the writer has seen have been in the cervical spine, although in the cases described in the literature these phenomena were found both in the dorsal and in the lumbar spines, as well as in the cervical spine.

SUMMARY

Hypertrophic changes are frequently seen on the anterior and lateral aspects of the vertebral bodies, but their presence on the posterior aspect, where they would encroach on the spinal canal, is very uncommon. They do, however, occur in this location and the author has reported cases with posterior projecting hypertrophic processes which apparently caused symptoms.

Hypertrophic changes occurring on the lateral aspects of the bodies of the vertebrae in the cervical spine may encroach on the canals for the cervical nerves and cause symptoms.

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OSTEITIS CONDENSANS ILII

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When examining roentgenograms of the pelvis, one occasionally notes in the ilium a localized area of increased density, involving usually the inferior and medial portion adjacent to the sacro-iliac joint.

In 1926 Sicard, Gally, and Haguenau in France discussed the condition and contributed five case reports. They spoke of osteitis condensans as having occurred elsewhere in the skeleton and described a case which involved the os calcis and also the fourth and fifth lumbar vertebrae. They took pains to exclude the possibility of an osteoplastic type of metastasis in the vertebral lesion.

Bársony and Polgár called attention to this condition in 1928, referring to it as "osteitis condensans ilii". Bársony described the lesion as a "sclerosing bone disease, easily demonstrable by x-ray and confined to the os ilii". These authors described fifteen cases which came to their attention in a period of one and one-half years.

The next mention of the subject was at a gynecological congress in Göttingen in 1932 when Fritz Berent correlated the condition to the trauma incident to childbirth.

During the past few years at the Kings County Hospital the authors have observed twelve patients who exhibited this condition. Complete roentgenographic and laboratory studies of these patients have been made and the findings form the basis of this paper.

Characteristically in this condition there occurs a zone of markedly dense bone in that portion of the ilium adjacent to the sacro-iliac synchondrosis; usually the involvement starts near the most inferior portion of the joint. It may be limited to a very small area, several millimeters in diameter, or it may involve the entire extent of the ilium as it adjoins the sacrum. The area may be sharply demarcated from the surrounding normal bone or it may gradually merge with it.

On the usual negative it appears as if that portion of the roentgenogram had been underexposed, as pointed out by Bársony; no trabeculae nor bony structures are visible in the involved area. On a purposely overexposed film, however, the bony trabeculae may be seen to be thickened and irregular. The lacunar spaces appear as if filled with a greater calcium deposit than usual, and the entire involved zone has a uniformly opaque appearance.

The sclerosis ends very abruptly at the sacro-iliac joint. The outer border of the lesion fades somewhat more gradually into the normal

iliac bone. The sacro-iliac joint proper never shows any evidence of involvement. The joint space is clear, is of normal width, and presents no irregularities of the articular surfaces either on the iliac or on the sacral side.

FIG. 1-A

Osteitis condensans ilii of the left side.

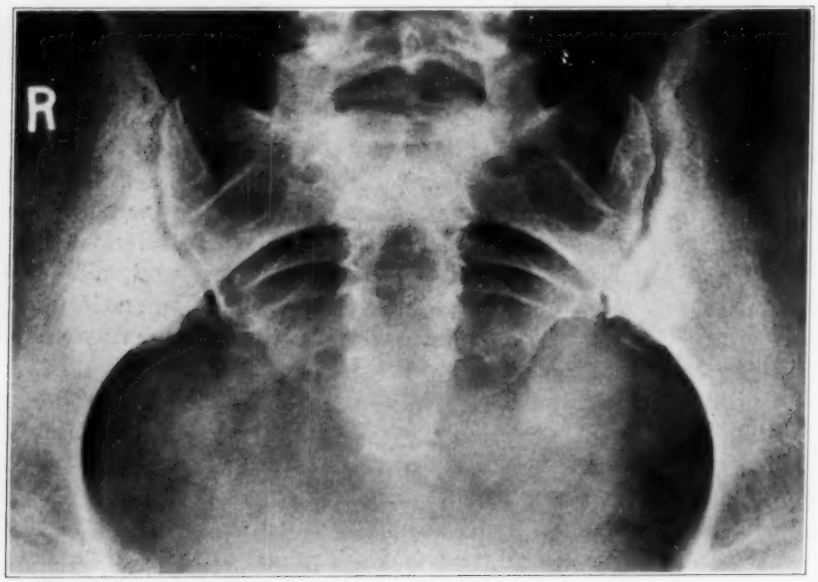

FIG. 1-B

Osteitis condensans ilii of the right side. Note the sharp demarcation of the sclerosed zone and the lack of involvement of the sacro-iliac joint.

The ordinary manifestations of any osteo-arthritis are absent.

Although the involvement appears to have its origin near the inferior portion of the joint, it may extend upward to involve a considerable portion of the iliac bone, even reaching to the crest. The entire iliac surface of the sacro-iliac joint may become sclerosed.

Due to the oblique direction of the joint, and because of the superimposition of the auricular surfaces of the ilium and sacrum, it often appears as if the sclerosis extends through the joint, involving the sacral side. Indeed, in cases where the sclerosis is particularly pronounced, it may be difficult to distinguish the articular space, the ilium and sacrum appearing almost as if fused. Roentgenograms taken in the oblique position to demonstrate the joint space readily prove that the process stops sharply at the iliac surface and does not involve the joint.

FIG. 2-A

Purposely overpenetrated film to show thickening of the bony trabeculae and filling in of the intertrabecular spaces. Note that, due to the superimposition of the iliac and sacral surfaces in the anteroposterior view, the process appears to extend across the joint space to involve the sacrum.

FIG. 2-B

Same case as Fig. 2-A. Oblique view showing that the process involves only the ilium and stops sharply at the sacro-iliac joint. The sacral surface is not involved.

Bársony states that the sacrum is never involved, but in one case of the authors' series a similar small zone of condensation was found on the sacral as well as on the iliac borders. Significantly enough, in this case the intervening joint shows no involvement.

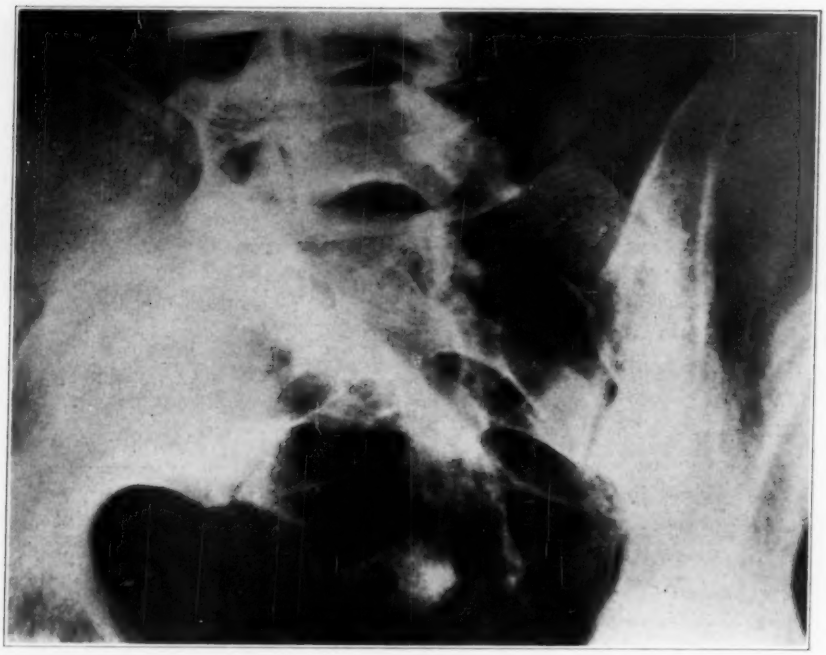

FIG. 3-A

FIG. 3-B

Bilateral osteitis condensans ilii. Oblique views illustrating the sharp limitation of the process to the iliac bone and the lack of encroachment on the sacro-iliac joint.

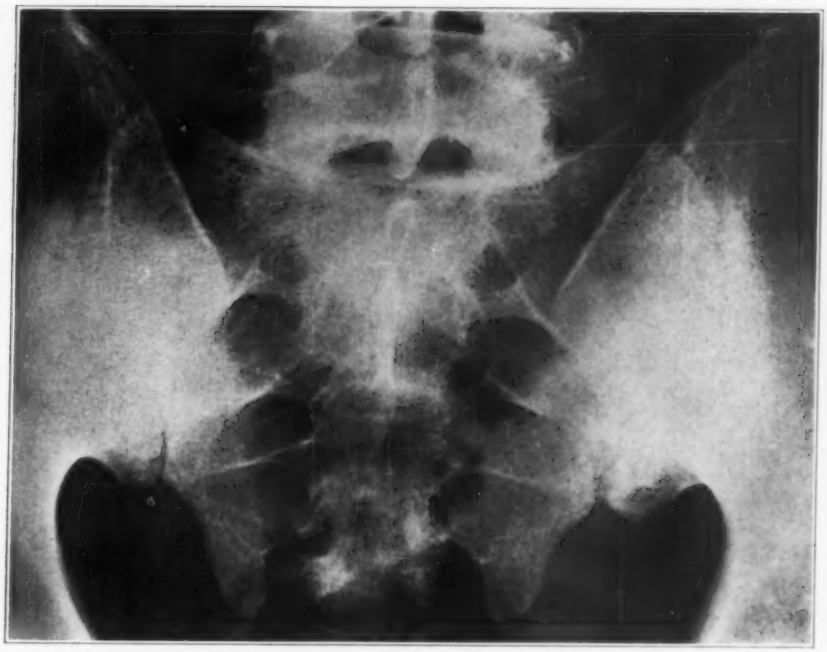

FIG. 4-A

Case F. H. Bilateral osteitis condensans ilii. Before operation.

FIG. 4-B

Same case. At operation a fairly large oblong section of bone was removed from that part of the ilium adjacent to the upper half of the sacro-iliac joint.

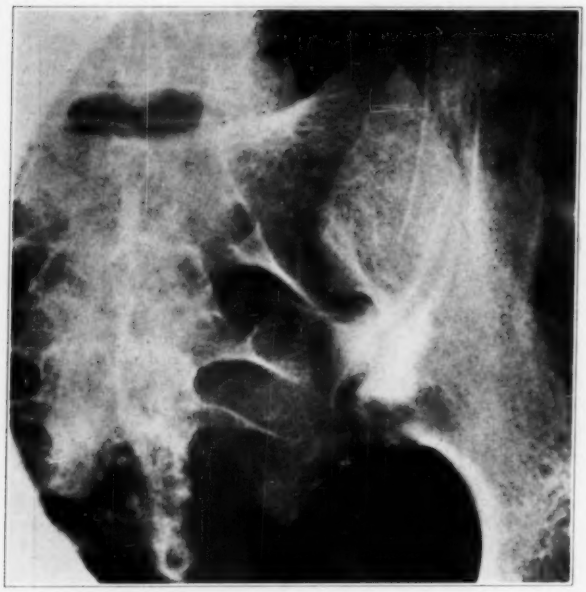

FIG. 5

Early case showing a very small area of condensation.

The condition has been described by others as being unilateral, although in four of the cases of the group here reported definite and equal bilateral involvement was observed.

Were it not for the fact that some of these cases present clinical complaints referable to this area, osteitis condensans would properly be relegated to the class of roentgenographic curiosities, interesting but of no known clinical significance.

However, some of these patients have definite complaints referable to the sacro-iliac region. In cases where symptoms occur, the complaint is usually that of low-back pain, often over the sacro-iliac region, either unilateral or bilateral, and frequently radiating down the posterior surface of the corresponding thigh and leg. The pain may be aggravated by bending; several patients complained of inability to lace their shoes. Relief may be obtained on assuming the recumbent position. Occasionally a limp may occur on the affected side. The degree of pain has not been proportionate to the extent of involvement. Whether these complaints can be entirely ascribed to osteitis condensans is, in the opinion of the authors, questionable. It must be stressed that in this series cases have occurred with very definite sclerosis, but without symptoms referable to this area. These cases are discovered incidentally to examinations of systems other than the skeletal. Such findings as a localized osteosclerosis should not be seized upon as the reason for any type of lumbosacral or sacro-iliac symptoms which the patient may present.

Physical findings in cases of osteitis condensans are usually scant and not very informative. Tenderness on palpation over the involved region and slight muscular spasm may be noted. The deep reflexes are normal.

Little is known in regard to the etiology. Fritz Berent in an earlier article definitely stated that osteitis condensans occurs only in females, usually in multiparae, and concluded that "Osteitis condensans is the result and late finding of periosteal, ligamentous, and capsular trauma due to gravidity and labor." He infers that this condition is limited to one

sex. This inference has been disproved by the series here reported, in which definite cases have been observed in the male. In the present series there were nine female and three male patients.

FIG. 6

Early case showing process limited to a small triangular area adjacent to the most inferior part of the sacro-iliac joint. The sacral surface appears to show similar involvement in this case.

Bone syphilis has been excluded in these cases by serological studies, by the history, and by the noncharacteristic type of bone involvement. Likewise, Paget's disease, sclerosing osteomyelitis, osteo-arthritis, tuberculosis, lymphogranulomatosis, Hodgkin's disease, marble-bone, and osteoplastic types of metastases have been given consideration and have been excluded to our satisfaction in all of the present cases.

A very thorough examination of the entire osseous system in each of the cases failed to show evidence of multiplicity of involvement. Likewise, the blood calcium and phosphorus determinations which were made in eight of the twelve cases were all normal and the phosphatase in the case in which an operation was performed was 7.2 units per 100 cubic centimeters of blood. A generalized disturbance of the calcium-phosphorus balance appears to be definitely excluded. Osteitis fibrosa and its variants merit no further consideration. Blood and urine studies likewise failed to uncover anything of significance.

As mentioned, Sicard, Gally, and Haguenau describe osteitis condensans as occurring also in the os calcis and in the fourth and fifth lumbar vertebrae. It seems probable that bones other than the sacrum may be involved by a similar process. We have observed one case that shows a striking and fairly extensive sclerosis of the coracoid and acromion processes as well as the axillary border of the scapula. This has not been included with those of the osteitis condensans series, but it does belong to the group of idiopathic localized osteoscleroses rather than to any other known entity.

Radiologists have frequently found small condensed and sclerosed islands of bone in various parts of the osseous system, particularly about

FIG. 7

Zones of condensation and sclerosis in the coracoid process, the acromion process, and the neck of the scapula. The relationship of these structures to osteitis condensans ilii is unknown.

the shoulder and the pelvis. While small compact bony islets are often referred to in the literature and in most texts, their significance is still lacking. Osteopoikilosis appears to be a more striking manifestation on a more widely distributed scale.

The question as to whether osteitis condensans ilii bears any relation to the above is necessarily for the future to determine, but, in the light of our present knowledge, no definite relationship suggests itself. The constancy of location and the extent and degree of sclerosis would seem to separate osteitis condensans ilii from the previously described small areas of condensed bone found occasionally in other parts of the skeleton.

Trauma as an etiological factor seems to deserve little consideration. While several of the patients of this series gave equivocal histories of having fallen or of having sustained some mild trauma at varying intervals prior to the onset of their symptoms, others in whom the sclerosis was most pronounced failed to give any history of antecedent injury. The etiological significance, therefore, remains questionable.

In a discussion of "ivory vertebrae", Bársony and Schulhof suggest that the sclerosis of ivory vertebrae may represent a reaction to a bacterial embolism with bacteria of low virulence. A local chronic infection might thereby be set up, and eburnation might result just as it does in Garrè's sclerosing osteomyelitis.

In the opinion of the authors, this possibility merits consideration in the etiology of osteitis condensans ilii. The variation in the extent of involvement in different cases—from an area of several millimeters to almost the entire sacral surface of the ilium—suggests a process of great chronicity, probably on a low-grade inflammatory basis. Cases have been followed and examined after one and one-half years without showing any appreciable change or progress in the roentgenograms.

A consideration of the blood supply of the ilium brings out a point of

interest and possibly of significance. A nutrient foramen occurs with great regularity in that part of the ilium adjacent to the inferior portion of the sacro-iliac joint. This is the part of the ilium that is the seat of osteitis condensans. That a relationship may exist between the local blood supply and the condensing osteitis is an interesting point to consider. It occasionally happens that instead of one foramen there are two or three nutrient foramina which are situated in this location, but which extend higher toward the crest. This may have a bearing on those cases of osteitis condensans in which the process is more extensive, involving almost the entire sacral surface of the ilium.

It is apparent that in this condition, as in so many others, the knowledge of the cause must wait upon thorough knowledge of the effect. Until we become thoroughly conversant with the histopathology, the etiology will in all likelihood remain obscure.

In one case of the present series, a section of sclerosed bone was removed during an operation to stabilize the joint. A review of the literature reveals no case in which there are operative or histological findings. It seems worthwhile, therefore, in view of the pathological data available, to present this case in somewhat greater detail.

F. H., male, aged thirty-six, married and the father of two children who were both well, five years previous to admission had begun to experience pain in the right sacro-iliac region. After bending, he would experience pain and difficulty in straightening up. The pain had been severe enough to incapacitate him for a week at a time. He had had short intervals that were symptom-free. There had been no sciatic radiation, the pain having been localized to the region over the sacro-iliac synchondrosis. There had been no past major illnesses. The occupation, that of salesman, could not possibly have played any etiological rôle.

In his youth, the patient had been very active and had participated in all the major sports. Six months after the original onset, he had fallen and landed on his right hip. This time he had been incapacitated for three weeks with the same type of pain in the right sacro-iliac region. A right-sided limp had followed this and the pain was present only at intervals, although there was always a sensation of residual soreness over the right sacro-iliac joint. The pain was always aggravated by bending. The patient managed to get along till January 2, 1935, when he had to be brought home from work and remained in bed for one month. While he was lying flat in bed the pain almost disappeared, except on twisting or turning. He entered the hospital on February 4 and again on March 21, 1935, with the diagnosis of sacro-iliac arthritis. The roentgenographic diagnosis was bilateral osteitis condensans ilii.

During the second admission, the patient was operated upon by the orthopaedic surgeon. The preoperative diagnosis was sacro-iliac arthritis, and a right sacro-iliac fusion was done. At operation, it was noted by the surgeon that the iliac bone adjacent to the right sacro-iliac joint was very sclerotic. The physical findings prior to operation were scant, there being present only a slight rigidity of the lumbar muscles. The laboratory findings were all essentially negative. The blood calcium was 11.1 milligrams per 100 cubic centimeters. The blood phosphorus was 3.9 milligrams per 100 cubic centimeters. The phosphatase was 7.2 units per 100 cubic centimeters of blood.

A section of bone was removed from the involved portion of the sacral surface of the ilium at operation for pathological study. The report of Dr. William Hala follows:

"There is a marked condensation of the osseous tissue with obliteration of the evident former lacunae. There appear to be no osteolytic or osteoclastic changes in the

bone and neither is there any evidence of overactivity of the osteoclasts or osteoblasts. In fact, these cells are more or less conspicuous by their absence. The marrow spaces contain an unusual number of myocytic and plasma types of cells. The significance of the plasma cells is undetermined. In general, the lesion appears to be of an osteitis condensans type. It is apparently independent of any inflammatory or other etiology, so far as can be ascertained from the histology of the specimen. Occasionally, in the condensed bone there appear to be depositions of lime salts which occur more or less in irregular linear areas, but more or less parallel to the lamellae of the bone. Diagnosis: osteitis condensans."

The patient was discharged after four weeks. He was still in a plaster jacket, but had obtained very marked relief.

Judging from the foregoing pathological report, it would appear that an inflammatory basis might be excluded, whereas from the roentgenographic picture such a basis seems quite likely.

It is to be noted that the operation in this case was not undertaken on account of the osteitis condensans, but was indicated, in the opinion of the orthopaedic surgeon, on account of the disabling character of the pain.

SUMMARY

We have an unusual bone affection characterized by a smaller or larger area of dense sclerosis, occurring on the iliac side of the sacro-iliac synchondrosis, not involving the sacro-iliac joint, and definitely not due to osteo-arthritis.

The nature of the etiology is not clear; the pathogenesis is unknown; and the clinical significance is debatable.

It does not fall definitely within the category of any of the known bone diseases or affections, but the type of lesion in the region of the nutrient foramen suggests a low-grade inflammatory nature.

It is important, if only to avoid ascribing clinical significance to a condition that may be more in the nature of an incidental roentgenographic finding.

Osteitis condensans should be carefully looked for in all roentgenograms of the pelvis and, when found, the cases should be completely investigated so that, as new facts and findings are gradually uncovered, much that is now uncertain and vague will become clear, and another entity may be added to the list of bone affections.

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THE EFFECTS OF HYPERCALCAEMIA ON JOINTS

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Hyperparathyroidism has been produced experimentally in animals with a resultant disease picture simulating generalized osteitis fibrosa cystica [1, 5, 6]. However, no mention of intra-articular pathology has been found in the vast literature dealing with the experimental work on the parathyroid hormones. In the clinical field, Oppel, in 1929, directed attention to the possible relationship which may exist between the ankylosing type of polyarthritis and hyperfunction of the parathyroid glands associated with hypercalcaemia and hypo-electro-excitation of the muscles. Partial parathyroidectomy was performed on forty-nine patients suffering from this condition, and thirty-three of them showed improvement with disappearance of the hypercalcaemia. Funsten, in 1933, also reported encouraging results following partial parathyroidectomy in fourteen arthritic patients with hypercalcaemia. After operation, thirteen of his patients showed marked improvement and nine of them were entirely relieved from symptoms.

It is well known that the feeding of large doses of vitamin D produces a high content of calcium in the blood [4, 7, 10] and resultant changes in the bones of experimental animals similar to those produced by the administration of parathormone [3, 8]. The exact mechanism by which these changes are brought about by vitamin D is not entirely understood. Taylor, Weld, Branion, and Kay believe that vitamin D acts through stimulation of the parathyroid glands by

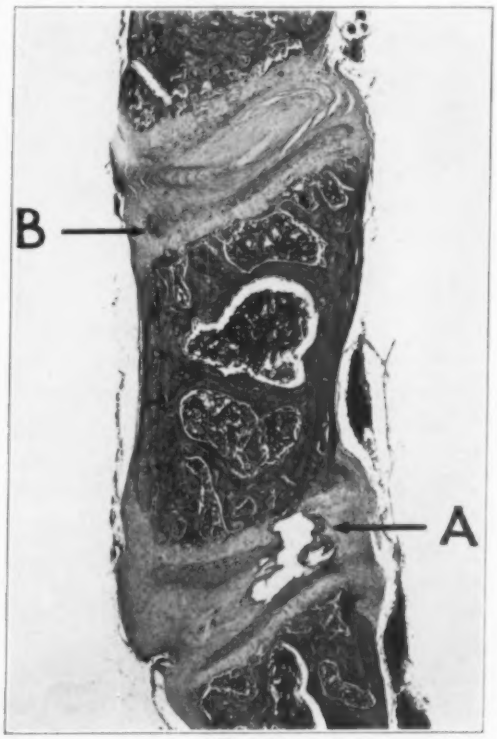

FIG. 1

Photomicrograph (× 29.5) of intervertebral disc, showing a large cystic space (*A*) with deposits of calcium at its periphery. Excessive calcium (*B*) is also shown at the margin of the other disc.

FIG. 2

Photomicrograph (× 120) of cartilage on the lower end of the femur, showing deposits of calcium (*A*) in its intermediate area.

the sterol. Johnson and others believe that vitamin D either stimulates the parathyroid glands to secrete more hormone, or intensifies the activity of the hormone in circulation, or supplements the effect of the hormone.

The object of the following experiments was to produce a prolonged hypercalcaemia through the feeding of large doses of vitamin D and to study the intra-articular structures for possible evidence of arthritic changes.

In the experiment, fifteen female albino rats, aged four weeks, were employed. The animals were divided equally into five groups of three each. The food for all animals consisted of the usual rat diet of corn bread, wheat flour, and cabbage. Those of Groups I, II, III, and V received normal amounts of this food and those of Group IV received only half the normal amount of food. The rats of Groups IV and V did not receive irradiated ergosterol and, therefore, served as control animals; in addition, it was possible to compare the changes resulting from malnutrition with those produced by hypercalcaemia. Each of the three animals in Group I was fed two milligrams of irradiated ergosterol daily; each in Group II, three milligrams daily; and each in Group III, five milligrams daily. The drug in the form of powder was mixed thoroughly with a very small portion of each meal. After the animal had consumed all of this small portion the remainder of the meal was given. Roentgenograms of all animals were made at weekly intervals. At autopsy, gross and microscopic examinations were made of the visceral organs such as the heart, aorta, lungs, liver, spleen, kidneys, adrenal glands, ovaries, thyroid and parathyroid glands, and on joints such as the knee and the spine.

The animals of Group I (fed with two milligrams of irradiated ergosterol daily) gained weight and showed no external or roentgenographic

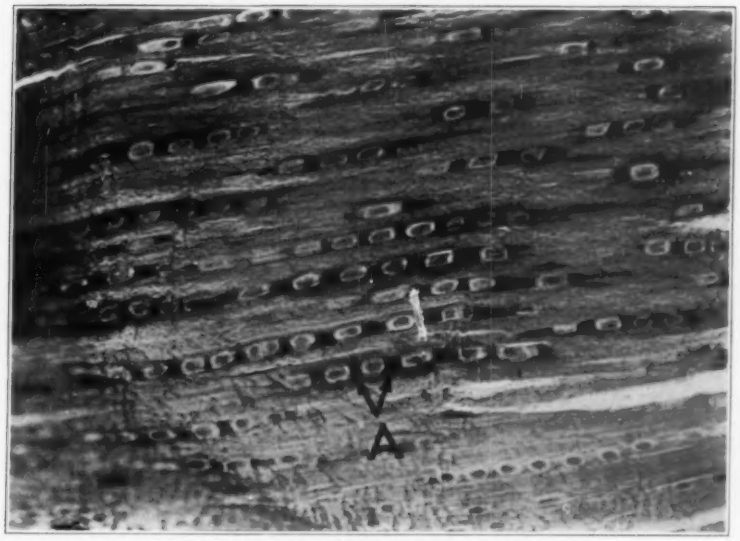

FIG. 3

Photomicrograph (× 210) showing a longitudinal section of the lateral ligament of the knee joint. Note the calcification (*A*) between the cells.

changes when compared with those of Control Group V. The animals in Groups II and III (fed with three and five milligrams of irradiated ergosterol daily) showed, in roentgenographic studies, marked decalcification of the skeletal system with cystic changes at the ends of the long bones as early as the third week after the administration of the drug. They became less active and very irritable on being disturbed; also, they failed to gain weight and some of them even lost weight. The animals in Group IV remained stationary in weight; their long bones, however, revealed diffuse absorption of calcium, but without the characteristic cystic changes at their ends.

At the end of six weeks an autopsy was performed on one animal of each group. Gross examination showed calcium deposits in the aorta in the animals from Groups II and III, and diminished resistance of the long bones to cutting in animals from Groups II, III, and IV. No other changes could be observed by the naked eye. Microscopic examination also revealed marked changes in the animals of Groups II and III. In the aorta there were extensive calcium deposits which, in places, occupied the entire circumference of the media. Calcification was noted in the heart muscle, just beneath the endocardium and near the valves. Also, calcareous deposits were seen in the arteries of the heart, lungs, and skeletal muscles and occasionally those of the liver, the spleen, and the kidneys. In various places the cartilage of the intervertebral discs showed deposits of calcium. In one place, the disc showed a large cystic space which was heavily lined with calcium and, as a result of this degeneration of the disc, the intervertebral space was markedly narrowed (Fig. 1). In the knee

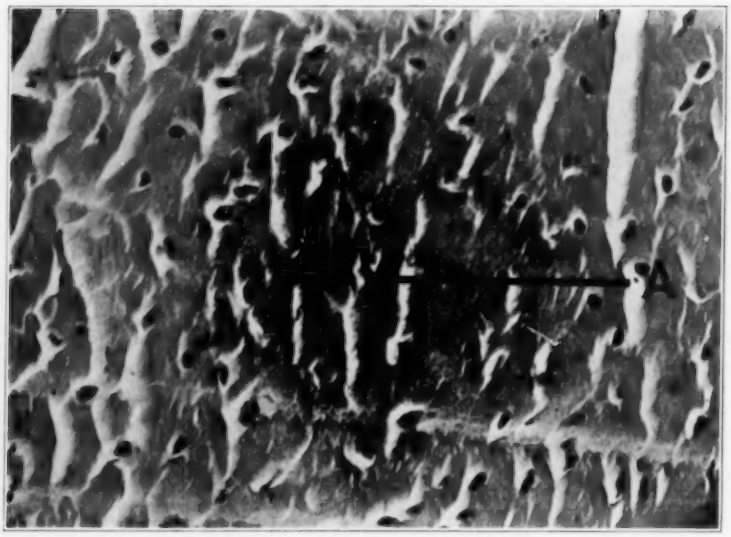

FIG. 4

Photomicrograph (× 298) showing a cross-section of the lateral ligament of the knee joint. Note the dense area of calcification (*A*) in the center of the field.

joints, several interesting observations were made. Deposits of calcium were seen in several sections of the central or weight-bearing portion of the cartilage (Fig. 2). The epiphyseal bodies which extend into the joints showed characteristic changes such as diffuse atrophy and enlarged marrow spaces. The synovial membrane showed normal findings, except for occasional areas of calcification of the larger arteries contained therein. The lateral ligaments of the knee joints also exhibited irregular areas of calcification (Figs. 3 and 4). The most marked calcium deposits were seen in the large para-articular collateral vessels. The microscopic findings in the case of the animal from Group I did not differ in any respect from those of the Control Groups IV and V.

At the end of twelve weeks an autopsy was performed on another animal of each group. The animals from Groups II and III showed pathological changes similar to those found after six weeks. Again, nothing of interest was found in the animals of Groups I and IV.

After the twelfth week the remaining animal in Group III was placed on a normal diet, without irradiated ergosterol, following which it gained weight rapidly and gradually recovered its normal appearance. Three weeks later, the animal was sacrificed and no trace of calcification could be found in any of the organs, and examination of the bones and joints showed normal findings. Autopsies were performed on the remaining animals of the other groups at the end of sixteen weeks, and the findings were similar to those seen in the other animals of the same groups after six and twelve weeks. Attention was directed toward the possible appearance of urinary calculi, with the result that numerous plaques of

calcium were observed in the smaller as well as in the larger blood vessels of the kidney and in the renal tubules. The parathyroid glands of the treated animals were sectioned in every case, but hyperplasia, adenomatous growth, or atrophy was not observed.

SUMMARY

In our experiments, chronic hypercalcaemia was produced in albino rats by prolonged administration of large doses of irradiated ergosterol. Characteristic osseous changes and metastatic calcification occurred chiefly in the blood vessels of various organs. The cartilage of the knee joints and of the intervertebral discs showed areas of degeneration with calcification,—changes not unlike those found in early degenerative arthritis of human joints. Calcification of the extra-articular collateral vessels of the knee joints was prominent, but probably of no specific significance, since the entire vascular system showed similar changes. There were no anatomical or histological changes in the parathyroid glands to support the contention of Taylor that vitamin D acts through the parathyroid glands.

The rat may recover completely from the effects of prolonged feeding of vitamin D within two to three weeks after the drug is withdrawn.

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FRACTURES IN PAGET'S DISEASE

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Our purpose in reporting the following eight cases of fracture in Paget's disease of bone is to discuss the frequency of this condition, the type of fracture, and the results of healing properties, and to review the literature, which is not extensive.

CASE 1. E. F. H., male, aged sixty-five, was examined on account of moderate pain and lameness which involved the region of the left hip. The roentgenograms showed definite Paget's disease involving the upper portion of the femur, especially about the greater trochanter. Three days later his physician reported that while stepping off a curbing the patient had fractured his hip. Another roentgenogram showed a transverse fracture through the trochanter without much displacement. The patient was treated by immobilization in a plaster cast, and union took place within two months.

This was a case of almost spontaneous fracture, caused simply by stepping off a curbing. The amount of pain was not great, and the case was not difficult to handle. The roentgenograms of this case are not reproducible.

CASE 2. J. F., male, aged fifty-seven, slipped on some ice as he was getting out of his automobile and felt his leg give way. He was brought to a hospital in an ambulance. He lay in bed with his left leg outwardly rotated. He was in moderate pain on being moved. Roentgenograms showed Paget's disease through the pelvis and upper left femur and a fracture, transverse and complete, just below the greater trochanter.

The patient was treated at first with a Thomas splint and skin traction, followed in three weeks by a plaster cast. He was very comfortable as soon as traction was applied. There was firm union in a reasonable length of time.

CASE 3. W. S. R., male, aged sixty-five, was known to have had progressive bowing of both legs for some time. His physician stated that the patient had stepped down one step and had fractured the right femur.

A roentgenogram, taken on admission to the hospital, showed a fracture of the midshaft of the right femur, without overriding. A few days later, while skin traction was being employed, displacement and overriding of one-half an inch occurred; this was reduced under skeletal traction. On account of the patient's mental condition, all traction had to be removed at the end of three weeks and he had to be put into a plaster spica.

He was seen two years later, and the fractured leg was then slightly longer than the opposite leg, because the bowing had been corrected too much. There was very little actual pain in this case, and union came quickly.

CASE 4. G. H., male, aged fifty-six, a railroad conductor, stepped off the train as it was moving slowly. As he did so, he felt a snap in the left lower leg.

He was admitted to the hospital and the roentgenogram showed Paget's disease, confined to the left tibia and fibula, and a complete transverse fracture of the lower and middle thirds of the tibia, without much displacement. There was very little pain and not much ecchymosis. The patient was not conscious of any trouble with his leg before the accident.

The leg was put into a plaster cast without anaesthesia, and in eight days the patient was discharged from the hospital on crutches. At the end of two months all apparatus was removed, and examination revealed good union.

About two months later, while walking in the railroad yard, the patient felt his leg give way and he received another fracture of the same tibia about four inches above the first fracture. This was not complete and it required a plaster cast for only a comparatively short time.

There is another patient (Case 6) in this series who sustained a second fracture.

CASE 5. J. R., male, aged sixty-one, while working as a longshoreman, was knocked down by a bale of wool. He received an injury to the cervical spine and fractures of the right tibia and fibula. On admission to the hospital he was in shock from the injury to his neck, and there was a queston of fracture of the cervical spine.

Roentgenographic examination revealed extensive Paget's disease, involving the whole spine and pelvis and the lower legs. The fracture was transverse and slightly comminuted.

FIG. 1

Case 2. Transverse fracture with overriding.

On account of the extensiveness of the changes in the spine, a complete blood analysis was done, with especial reference to calcium, phosphorus, and phosphatase, and the findings were normal. This was done to rule out other bone conditions.

Union was complete within three months.

FIG. 2

Case 4. Lower fracture, complete; upper fracture, incomplete.

CASE 6. W. F., male, aged sixty-two, while walking on the street in 1932, had suddenly felt his right leg snap as if something had given way. There had been no actual pain. He had called a taxi and had been taken to a hospital where examination had disclosed a complete transverse fracture of the middle and lower thirds of the tibia. The fragments had united readily.

In 1935, while walking along the street, the patient felt a snap and a tingling sensation, and the leg became weak, with very little pain. He went to a hospital and roentgenographic examination showed an incomplete fracture of the upper and middle thirds of the same leg.

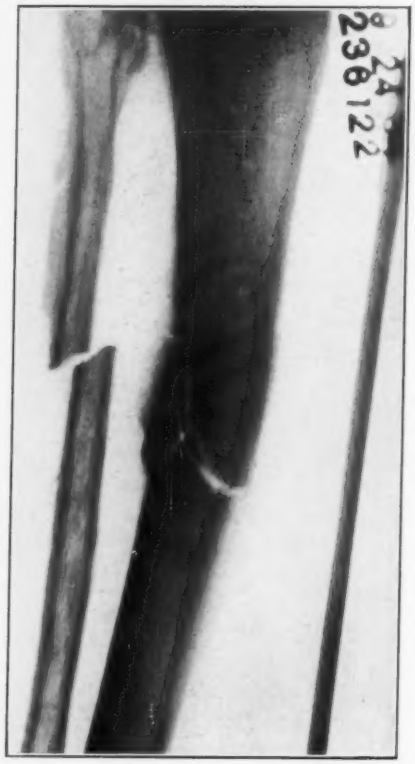

FIG. 3

Case 5. Extensive Paget's disease throughout the spine. Moderate changes in the tibia and in the fibula.

This case and Case 4 represent double fractures, the second being incomplete.

CASE 7. R. C., male, aged fifty-three, a letter-carrier, slipped on some ice and sustained a fracture of the patella. The exact mechanism of the injury is not known, but probably it was not an extreme trauma.

On taking roentgenograms, it was found that the patient had Paget's disease, involving the tibia and the patella. At operation, the capsule was sutured and the patellar fragments were held by catgut sutures through the fascia. There was fibrous union of the patella with resultant moderate loss of function. The patient was not able to resume his work as a letter-carrier. For this reason a second operation was performed in which fascia lata was inserted through drill holes in the patella. Nothing very startling was found on cutting down on the patella, except that there was very little bleeding from the bone. Sufficient time has not elapsed to know whether or not bone union will take place.

FIG. 4

Case 6. Lower fracture, received three years previously, shows fracture line. Recent fracture shows no displacement.

FIG. 5

Case 8. Very slight incomplete fracture line.

The following case is a very interesting one because it represents an incomplete fracture which could be very easily overlooked.

CASE 8. J. B. L., male, aged sixty, was known to have Paget's disease of one tibia. He was under treatment for diabetes and then had a mild hemiplegia, involving the right arm and leg. In three weeks' time he showed no evidence of spasticity. While standing, he began to dance to show how well he was when he felt a sharp pain below the knee. This kept him in bed for a month, and at first he was unable to raise his right leg. There was no hematoma and only slight local tenderness.

At the end of six weeks, after the patient had been up on crutches, roentgenograms showed an incomplete fracture line below the tibial tubercle. A possible fracture was masked by the other conditions, and the pain, weakness, and disability were supposed to be due to a circulatory condition. Of course, rest in bed brought about a good recovery.

In an analysis of these cases certain clinical facts are prominent. It is difficult to understand why such a process as Paget's disease with the gross thickening of the cortex should be subject to a'most spontaneous or pathological fracture. This is discussed in the literature without any satisfactory answer being given. Only one of these eight patients (Case 5) was subjected to a violent trauma and, in this case, we are not sure that the injury to the tibia was extreme.

The absence of pain in these cases was quite noticeable. Case 5 is an illustration. All our attention was at first directed to the injury to the cervical spine, but, as soon as the patient was well over the shock, we felt that the position of the fragments of the tibia was not good enough. Therefore, the patient was anaesthetized and, with use of the fluoroscope, better reduction was attempted. On account of the type of fracture, the alignment was not improved, and the plaster was removed. The limb was then put on extension. It was possible to obtain better position and to manipulate better without anaesthesia, because the pain element was not prominent; the fragments could be manipulated without causing pain. The history of Case 6, in which the patient had a complete fracture and yet was able to get into a taxi to go to the hospital, is not quite the usual story.

In all of these cases there was a very definite tendency toward a transverse fracture, without comminution. Someone has likened this condition to the breaking of a peeled banana, which is quite apt. The two cases which simulated intertrochanteric fracture were really cases of transverse fracture of the shaft.

Every case showed normal, or probably better than normal, callus formation, and the care of these fractures was not difficult. The two cases which presented two fractures in the same tibia at different times (Cases 4 and 6) did not sustain the second fractures at the site of the original ones.

We have no means of determining from this series of cases the frequency of fractures in Paget's disease and the liability toward spontaneous fracture. Therefore it is improper to say that patients with Paget's disease should be warned of this possibility. No one has reported a large series of cases. It would be necessary to collect all the cases of Paget's disease that we have observed and then to take a percentage, but this would not be an accurate figure because personally we might be seeing the

cases of fracture without considering the disease as a whole. The frequency of such fractures might be 10 or 15 per cent. in our practice, and this is not true as a whole. The fact that so few writers have published more than three cases in their own series makes us believe that it is not a common occurrence. Therefore, we would not feel like warning patients of the possibility, without more evidence of frequency.

There is a difference of opinion as to whether Paget's disease renders bone more or less susceptible to fracture. Statistics regarding the incidence of fracture in Paget's disease give us little help in this respect. Hallerman states that he has never seen a spontaneous fracture in seventy autopsies of cases of Paget's disease, while Naville found twenty-five fractures in 170 cases of osteitis deformans in the literature. The latter finding is hardly a reliable index, inasmuch as the disease often goes unnoticed during life unless fracture takes place.

Ewald believes that fractures are uncommon in Paget's disease. He thinks that the bone is rendered more resistant to trauma by reason of its modified structure. It is thicker and there is a large amount of tough connective tissue which, together with decalcification, gives increased elasticity; consequently, under pressure the bone would tend to bend rather than to break. He, therefore, is of the opinion that most spontaneous fractures reported in the literature are not associated with Paget's disease but with Recklinghausen's disease (osteitis fibrosa cystica), which is pathologically similar to the former and is very susceptible to spontaneous fracture. Donati is of the same opinion as Ewald.

Other writers, basing their views on clinical impressions, believe that there is a greater fragility of the diseased bone in Paget's disease and that therefore this bone fractures more easily than normal bone. To substantiate this view, Oberzimmer describes twelve fractures (four observed personally—two of which were in one bone—and eight cases from the literature, reported by Kraas, Smith, and Looser) and concludes that, although spontaneous fracture may not be frequent, a minimal trauma may be responsible for fracture. Woytek reports seven fractures, four of which were spontaneous and three of which (occurring in one patient) resulted from minimal trauma. He concludes that the frequent occurrence of fracture in Paget's disease from trauma which would not ordinarily result in fracture of normal bone and the occurrence of repeated fractures in one individual with Paget's disease are evidence of increased susceptibility to fracture. Love reports three cases of spontaneous fracture, which he believes to be an uncommon complication in the absence of myelomatosis. Philips reports six pathological fractures; Le Wald describes four; Murphy, Konjetzny, Rocher and Pouyanne, Arnulf and Van der Linden, and Lewin each report one case.

Although the traumata in most of the reported cases were indirect in character, the resulting fractures, as shown by roentgenograms, were transverse and without spicules rather than oblique or spiral. Ewald and Looser both describe the appearance very appropriately as resembling "a peeled banana broken in two".

Little consideration has been given in the literature to the element of pain in these fractures. Murphy does make special note of the "absence of severe pain"; Ewald states that the fractures may be painless; and Rocher and Pouyanne, in their case history, remark that the patient had "slight pain".

As for healing, there is practically general agreement that callus is laid down rapidly and union usually takes place in the normal length of time.

CONCLUSIONS

1. In spite of the gross thickening of the long bones in Paget's disease, there is a definite tendency to fracture, which is generally caused by slight trauma.

2. There is a definite loss of sensation of pain, so that these fractures can be easily handled.

3. There is an early appearance of callus and new bone formation.

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THE PATHOLOGY AND TREATMENT OF TENNIS ELBOW

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A condition, the symptoms and signs of which are as constant as those of tennis elbow, may well be supposed to have but one pathology and, as a corollary, but one type of treatment. The purpose, then, of this paper is to present a synopsis of the opinions held on the pathology of tennis elbow and to single out the most probably correct. Further, an attempt is made to reconcile apparently contradictory views on treatment and to promote the adoption of a simple and quick method.

PREDISPOSING FACTORS

Work or play which entails repeated pronation and supination movements with the elbow almost fully extended is essential for the development of a tennis elbow; those patients who remember no special overexertion will be found to be working at screwing, lifting, hammering, ironing, etc., or to be violinists, surgeons, masseurs, etc.

Cubitus valgus, mentioned by Preiser [22], is obviously important, but many patients do not show it. Of course, the smaller the carrying angle the greater will be the strain on the outer side of the elbow joint when the extended forearm is vigorously supinated or when a weight is carried with an extended and supinated forearm. The roentgenograms reproduced in various articles often show considerable valgus,—*e.g.*, Merlini's [57] Case 2, Bergmann's [49] Case 2.

Rheumatism,[3, 63] suppressed gout,[3, 19] the arthritic diathesis, and focal sepsis [28, 68, 69, 80, 88] have all been suggested as determining the chronicity of the lesion in tennis elbow, once it has occurred. Though these may have some bearing in the older patients, they are probably coincidental, since treatment to the elbow alone clears the condition up permanently. Moreover, other chronic conditions about joints—golfer's elbow and rider's sprain are the most analagous—are not considered due to anything but the original trauma, and it is clearly only the long duration and the refractoriness to treatment that have suggested these contributory factors. When the general adoption of adequate treatment has lessened the period of disability, little will probably be heard of this theory.

DURATION

The condition usually clears up in eight to twelve months without any treatment except perhaps avoidance of the painful movements for a time. Cases lasting much longer, however, are encountered. Merlini [57] described two cases in fencers, which lasted seventeen and twenty years respectively; Ochsenius's [53] patient, however, who was supposed to have had a tennis elbow for twenty-seven years, cannot be included, since he

was treated after two years' disability by iodoform injections into the joint under the mistaken diagnosis of a tuberculous arthritis. When last seen he had a marked osteo-arthritis of the elbow and showed Preiser's incongruence. Others have reported durations of from four to six years,—Coudere [10], Tavernier [44], and Ferrero [58].

FREEDOM FROM RECURRENCE

A tennis elbow, once it is well, does not tend to recur. This is the common experience of everyone, but the fact has never been stressed. Although an ordinary muscular stiffness (Clado's "*courbature*" [15]) may pass off completely and return on exercise, no case of recurrence after full development of the syndrome has ever been reported. Hansson and Horwich [74] mention two patients, both Davis-Cup players, who were free from symptoms six and fourteen years respectively after recovery. Knoll [82] found that six out of forty-one international players had had tennis elbow and had recovered, so that it would almost appear to be a condition to be expected, borne, and recovered from in the course of training among this class of sportsmen.

Further information on this point was obtained by an inquiry sent to those authors who had cited themselves as sufferers. Six replies were received (see References) in all of which recurrence was denied after the lapse of seven, nine, thirteen, thirteen, twenty-two, and twenty-four years respectively, although the game or work responsible had been resumed as soon as the elbow had become well.

POSITION OF AREA OF MAXIMUM TENDERNESS

This has been variously stated as:

1. On the tip of the epicondyle (most authors);
2. On the posterior surface of the epicondyle (Fisher [60]);
3. On the anterior surface of the epicondyle (Vulliet [21], Tavernier [44]);
4. On the radiohumeral joint line (Trethowan [71], Bankart [83]);
5. On the capsule of the elbow joint (Preiser [17], Glass [65]);
6. Above the epicondyle (Bertocchi [54], Ogilvie [66]);
7. Over the radio-ulnar joint (Fisher [60]).

Since the precise position is of importance for the elucidation of the pathology, particular care was taken in the writer's series to determine this accurately. Of the twenty-two elbows reported here, twenty were tenderest on the anterior aspect of the lateral epicondyle, one on the apex of the epicondyle, and one on the extensor bellies. Nearly all were more tender on the radiohumeral joint line than on the *apex* of the epicondyle,—a fact which may account for the statement that the tenderness is greatest on the joint line, for the anterior face of the epicondyle is not easy to get at and can be palpated firmly only with the elbow flexed. Occasionally the radiohumeral capsule was slightly tender; in no case

was the head of the radius tender. Pressure on the most tender area gave rise to the typical referred pain down to the back of the wrist. Careful palpation here shows that the tenderness is where the lateral part of the common extensor tendon arises from the bone; the finger is not directly on the bone, but on the almost as hard tenoperiosteal junction, just medial to the ridge formed by the edge of the tendon.

VARIETIES OF TENNIS ELBOW

I. *Acute—Following Indirect Trauma*

The disability dates from an acute pain and the feeling of something giving way at the elbow during the performance of a violent action. On the outer side of the forearm, just below the epicondyle, a swelling appears which subsides in a week or less. Only once in the whole literature has bruising been noted [15]. The tenderness is on the upper part of the extensor bellies in the forearm and the lesion is almost certainly a muscular rupture. Heald [80] states that cases of sudden onset show tenderness chiefly of the muscles. Rosenburg [52] has reported a rupture of the extensor carpi radialis longus: the onset was sudden; swelling was present; and the patient became perfectly well in two and a half years without treatment. The writer reports a similar case, but such cases are uncommon.

II. *Subacute—Following Indirect Trauma*

This is the typical variety, usually found in younger patients. The onset is gradual and follows vigorous exercise with the arm. The symptoms subside when the elbow is rested, but reappear with more intensity when the game is resumed until finally the patient can hardly turn a door-handle or lift a teapot. The syndrome may take a few days or weeks to reach its zenith, and spontaneous cure is probable in the end. The tenderness is on the epicondyle.

III. *Chronic Occupational*

One or more months may be required for the full development of this type, which is usually found in older patients. Often no history of an injury is obtainable, but the patient's occupation at once provides the clue. Although the pain and disability are not so severe as in the acute variety, the tendency to spontaneous cure is less than in the acute type.

IV. *Following Direct Trauma*

Thirteen cases of development of a tennis elbow after a direct injury to the lateral epicondyle have been reported (Momburg [23], Coues [29], Dubs [38], Jungmann [47], Fischer [48], Frey [59], Bryce [73]), and the writer describes another. Furthermore, in Carp's [81] Cases 3 and 7 a radiohumeral bursitis developed after a direct injury to the outer side of the elbow. As a rule, in severity and duration they resemble the chronic variety described. Since no tear of ligaments, muscles, or tendons can occur

as the result of direct injury, this variety is important because of the light it throws on the pathology.

TREATMENT

UNCERTAIN TREATMENTS

Only a list of these treatments will be given as they are of small significance and have little effect on the course of the disability. They include: rest, strapping, pressure pads, painting with iodine, etc., blistering, hot baths, hot air, luminous heat, galvanism, faradism, diathermy, cauterization, ionization, ultra-violet light, x-rays; injections of alcohol, carbolic acid, or novocain; removal of focal sepsis; vitamin D, thyroid gland, salicylates, given internally.

Massage is regarded as definitely harmful by some (Vulliet [21], v. Goeldel [30], Bergmann [49], Edgar [63], Mau [77], Hohmann [85]) and is advocated by others (Rivière [12], Bähr [14], Clado [15], Preiser [17], Cooke [42], Romer [43]), particularly by Bankart [83] and Tucker [88] who advise deep massage to the painful area. A periostitis visible in the roentgenogram is generally regarded as an indication for immobilization.

SUCCESSFUL TREATMENTS

No Treatment

As has already been mentioned, spontaneous cure is probable by the end of eight to twelve months. Keeping the arm in a sling does not appear to help much, probably because the natural position for the forearm held thus is pronation with the wrist flexed; the extensor muscles are therefore not relaxed.

Cock-Up Splintage

This is a most rational way of relaxing the extensor muscles and of allowing healing to take place uninterruptedly. Hansson and Horwich [74] adopted it in sixteen cases and obtained cure in twelve. In only two cases had the disability lasted more than ten weeks: six months in one which terminated successfully; two years in the other which resulted in failure. The average period during which the splint was worn was thirty-two days with extremes of sixty-seven and eight. Only two patients were under forty years of age. Spitzy [75] proposed relaxing the extensors still more by splinting the fingers in extension and the elbow at a right-angle as well, but Mau [77] found the fingers to be so stiff afterward that he advised against this elaboration. Ordinary cock-up splintage appears, therefore, to be a cheap and effective, if a somewhat slow and cumbersome, method of treatment, most suited to the recent case. Should the writer's opinion on the pathology be correct, this treatment is open to the theoretical objection that it makes recurrence possible, since healing without lengthening will probably occur.

Mobilization

Only the English authors advise this treatment (Romer [43], Mills [56], Fisher [60], Edgar [63], Ogilvie [66], Trethowan [71], Marlin [72], Bryce [73], Bankart [83],

Mennell [87], and Tucker [88]). They are all agreed that in chronic neglected cases mobilization is the correct treatment. Trethowan and Ogilvie regard mobilization as having no place in the treatment of the recent case and Heald [80] considers it harmful if used too soon. Verrall [67] states that Mills's manipulation cures a third of the cases in which it is tried, while up to 1928 Mills had not had a single failure. Mills was always able to obtain a crack or a click from the elbow when it was mobilized. Ogilvie found that when no click was elicited, the elbow was not cured. Marlin states that the snapping noise is without significance and can always be produced in the other elbow. Mills stands alone in advocating mobilization in the acute as well as in the chronic stage. He points out that not all tennis elbows can be caused by adhesions and mentions a patient whose elbow "went out"; the elbow was mobilized at midday and the patient could play again the same afternoon.

The mobilization itself consists of various modifications of forcing full extension at the elbow. The method most usually adopted is undoubtedly Mills's,—with the forearm fully pronated and the wrist and fingers flexed, the elbow is forcibly extended; thus the greatest possible pull is exerted on the muscles attached to the lateral epicondyle. Bankart advises the same in the reverse order; Marlin, extension at the elbow with the forearm in the midposition; Bryce, pure extension. Tucker mentions Mills's procedure combined with pressure to produce a cubitus varus and, in addition, suggests forced full extension at the elbow with the forearm supinated and adducted. There is general agreement that anaesthesia is helpful and usually necessary; the mobilization is hardly ever repeated.

It is interesting to note that though mobilization, particularly by Mills's method, is the very reverse of cock-up splintage, both are advocated for the same condition, and by some, even for the same stage of the same condition.

Periosteal Excision

This method has been practised by Franke [20], v. Goeldel [30], Fischer [48], Bergmann [49], and Merlini [57]. Fischer's Case 7 is particularly interesting in that he first removed the subcutaneous fascia and fat over the lateral epicondyle and, when the patient failed to benefit, operated again and removed the epicondylar periosteum, this time effecting a cure. He regularly obtained good results with this method and described four cases of immediate relief after excision. However it is not possible to assess the value of this operation as the number of patients operated on and the late result are not given by all these authors, but its effect is doubtless the same as that obtained by Hohmann's operation. That it is not always successful is shown by Merlini's Case 4 in which the patient was relieved for only six months.

Division of the Muscular Origin at the Epicondyle

Hohmann [85] describes this operation (first practised by Codman [40]

over fifteen years ago), which effectively relieves the tension on the epicondyle and allows the inflammation to resolve undisturbed. He exposes the epicondyle and divides the muscular attachment on the front of it,—chiefly the origin of the extensor carpi radialis brevis. Fourteen of Hohmann's fifteen patients were cured within a week of the operation, and Mau's four patients, aged thirty-eight to fifty-five, remained well after intervals of one, two and one-half, three, and three years respectively. On the other hand, Gebhardt [84] has seen three cases of this operation, in all of which recurrence began at the end of a year. The grip was not weakened afterward. If cock-up splintage and mobilization have both failed to relieve a patient, Hohmann's operation appears to the writer to be the best and the most reasonable.

Bursting or Removing a Bursa

Schmitt [39] described a case of stiffness in the left elbow lasting for four years, a swelling of two years' duration, and pain persisting for three weeks, caused by a calcified bursa at the lateral epicondyle visible in the roentgenogram. This bursa was removed. Osgood [40] reported three cases, in two of which immediate and lasting relief followed excision of the radiohumeral bursa. Dittrich [62] also removed one, thereby curing his patient, who remained well five months later. Carp's [81] contribution to the study of this condition is most important; he collected eight cases of radiohumeral bursitis, in five of which the calcified bursa was visible in the roentgenogram; in four of these the bursa disappeared after treatment. Digital pressure calculated to burst the bursa led to a dramatic and permanent cure in four; one bursa was excised. Rest and heat for from three to six weeks sufficed to relieve the remaining three patients, two of whom were still well one and five years later. Howell's [68] one patient refused operation.

Therefore, on the rare occasions when the physical signs suggest the presence of an inflamed bursa, bursting by digital pressure appears the best treatment; if this fails, rest and heat or excision will be indicated according to circumstances.

Disengaging or Removing Synovial Fringes

By 1929 Trethowan [71] had removed hyperaemic synovial fringes in the *radiohumeral* joint on eight occasions, with cure in all. Fisher [60] has described a manipulation partly designed to set free nipped synovial fringes in the *radio-ulnar* joint. While the joint is extended from the position of full flexion, quick pronation and supination movements are made; at the same time pressure is exerted on the outer side of the elbow. In all of Trethowan's patients the tenderness was greatest on the antero-lateral aspect of the radiohumeral joint line, and in chronic cases which show this sign and which are refractory to other treatment the joint may well be opened with the intention of removing a synovial fringe.

The Writer's Method

This has the merit of being simple and quick, and it does not necessitate an anaesthetic. It is equally applicable to cases of some hours' duration and to those of some years' standing; it is not unduly painful; and it can be carried out by any masseur.

While the patient sits with the elbow held at a right angle and the forearm supinated, deep friction is applied to the anterior part of the lateral epicondyle; the patient's skin moves with the masseur's finger, so as to rub the superficial tissues on the deep structures. This is continued for five or ten minutes,—the more chronic the condition, the longer is the period of friction. The elbow is then mobilized. (Since the amount of lateral wobble at the elbow when the forearm is extended and supinated varies considerably from person to person, it is well to compare the two sides before beginning.) The elbow is as fully extended and the forearm is as fully supinated as possible. With one hand on the inner side of the elbow and the other on the outer side of the wrist, the masseur adducts the forearm on the arm with a sharp jerk toward a position of cubitus varus. A crack is usually heard, which is sometimes also obtainable from the other elbow, but the manipulation is just as effective if no sound is heard. There are no muscles capable of opposing this movement, so that anaesthesia is valueless except to avoid the pain, which in any case is slight. The deep massage to the tender area and the mobilization are repeated thrice weekly until the patient is well; one treatment is seldom enough. This is another argument against anaesthesia, especially as no more can be done with it than without it. After this treatment the elbow is often a little sore for an hour or two, but it then improves to far beyond the original state. In the writer's series an average of four treatments was enough to give complete relief, with extremes of one and nine. The offending work or play was resumed as soon as the patient was fit, in all cases by the time treatment ceased.

COMMENT ON TREATMENT

The fact that a particular operation gives complete relief is no proof of the correctness of the theory on which it is based. For example, Carter [50] operated on three elbows in search of a radiohumeral bursa, did not find it, and cured the condition. Ogilvie [66] has reported eight more such cases; Fischer [48], two; and Verrall [67] and Bankart [83], a further unspecified number. Again, Tucker [88], who does not mention radiohumeral bursitis among the possible pathologies of tennis elbow, recommends Osgood's operation in cases resistant to ordinary treatment.

Apart from the rare occasions when an inflamed bursa or, possibly, a hyperaemic synovial fringe is found and removed, all the rational treatments aim at preventing tension on the epicondyle. Relaxation of the extensor muscles can be insured by cock-up splintage, and local relief of tension is secured by separation of the common extensor tendon from the bone either by operative division or by pulling it off. According to the

over fifteen years ago), which effectively relieves the tension on the epicondyle and allows the inflammation to resolve undisturbed. He exposes the epicondyle and divides the muscular attachment on the front of it,—chiefly the origin of the extensor carpi radialis brevis. Fourteen of Hohmann's fifteen patients were cured within a week of the operation, and Mau's four patients, aged thirty-eight to fifty-five, remained well after intervals of one, two and one-half, three, and three years respectively. On the other hand, Gebhardt [84] has seen three cases of this operation, in all of which recurrence began at the end of a year. The grip was not weakened afterward. If cock-up splintage and mobilization have both failed to relieve a patient, Hohmann's operation appears to the writer to be the best and the most reasonable.

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COMMENT ON TREATMENT

The fact that a particular operation gives complete relief is no proof of the correctness of the theory on which it is based. For example, Carter [50] operated on three elbows in search of a radiohumeral bursa, did not find it, and cured the condition. Ogilvie [66] has reported eight more such cases; Fischer [48], two; and Verrall [67] and Bankart [83], a further unspecified number. Again, Tucker [88], who does not mention radiohumeral bursitis among the possible pathologies of tennis elbow, recommends Osgood's operation in cases resistant to ordinary treatment.

Apart from the rare occasions when an inflamed bursa or, possibly, a hyperaemic synovial fringe is found and removed, all the rational treatments aim at preventing tension on the epicondyle. Relaxation of the extensor muscles can be insured by cock-up splintage, and local relief of tension is secured by separation of the common extensor tendon from the bone either by operative division or by pulling it off. According to the

FIG. 1

Case 6. Right elbow four weeks after the injury. Note periostitis of the lateral epicondyle.

FIG. 2

Case 6. Four weeks after treatment—four mobilizations in eight days—had been finished. The patient was symptom-free during this period. Note much diminished density of epicondylar shadow.

FIG. 3

Case 6. After six months of freedom from symptoms. Note slight diminution in size of the shadow.

TABLE I

SUMMARY OF CASES

Case	Sex	Age (*Years*)	Cause or Occupation	Duration of Symptoms	Side	Type	Cubitus Valgus	No. of Treatments	Duration of Treatment	Immediate Results	Late Results
1.	Male	45	Tennis	3 years	Right	Acute	None	6	1 month	Much improved.	After several months could play tennis painlessly.
2.	Male	23	Tennis	3 weeks	Right	Subacute	None	2	4 days	Full relief.	Untraced.
3.	Male	24	Tennis	7 months	Right	Subacute	None	4	10 days	Full relief.	4 months: still well.
4.	Male	35	Tennis	5 weeks	Right	Subacute	None	1		Full relief.	3 years: still well.
5.	Female	36	Badminton	4 weeks	Right	Subacute	None	3	5 days	Full relief.	16 months: still well.
6.	Female	47	Fall on hand	5 weeks	Right	Subacute	None	4	8 days	Full relief.	6 months: still well.
7.	Female	18	Carrying weight	8 days	Right	Subacute	None	1		Full relief.	8 months: still well.
8.	Female	48	Using spring-cutter in left hand	8 months	Left	Subacute	+	13	3 months	No improvement.	Wore a cock-up plaster on wrist 4 months, with full relief; 2 months later, still well.
9.	Female	34	Reining in horse	5 weeks	Right	Subacute	None	7	10 weeks	Full relief.	6 months: still well.
10.	Female	49	Carrying heavy stones	7 months	Right	Subacute	None	8	4 weeks	Nearly well.	1 month: full relief. 4 months: still well.
11.	Female	45	Carrying weight Housework	5 days 9 weeks	Left Right	Subacute Occupational	+ +	3 7	4 months 6 weeks	Full relief. Full relief.	1 year: both elbows get stiff easily.
12.	Male	56	Violinist	36 hours	Right	Occupational	None	3	6 days	Full relief.	1 year: still well.
13.	Female	51	Housework	2 days	Left	Occupational	+ +	1		Full relief.	2 years: still well.
14.	Female	53	Chopping wood	3 years	Right Left	Occupational Occupational	None None	9 5	6 weeks 9 days	Full relief. Full relief.	16 months: still well.
15.	Female	51	Housework	1 month	Left	Occupational	None	1		Full relief.	1 year: still well.
16.	Female	48	Lifting books	7 months	Right	Occupational	None	5	16 days	Full relief.	10 months: still well.
17.	Female	61	Lifting chair	5 months	Right	Occupational	+	5	3 weeks	Full relief.	6 months: still well.
18.	Female	59	Giving massage with painful shoulder	4 days	Right	Occupational	None	1		Full relief.	8 months: still well.
19.	Male	50	Pianist	5 months	Right	Occupational	None	2	3 weeks	Full relief.	5 months: still well.
20.	Female	45	Secretary	2 years	Left	Direct	None	3	6 days	Full relief.	2 years: still well.

TABLE II

ANALYSIS OF FINDINGS

Patients		20
Male	6	
Female	14	
Elbows		22
Right	14	
Left	4	
Both	2	
Age at Onset:		
Under 20 years		1
20 to 29 years		2
30 to 39 years		3
40 to 49 years		7
50 to 59 years		6
Over 60 years		1

writer, the success of mobilization in a case of tennis elbow depends upon the conversion of a partial tear of the tendinous origin into a complete tear; the epicondylar periosteum, now separated from the extensor tendon, is spared direct pulls, and healing with slight permanent lengthening occurs as it would in tendinous structures elsewhere. Cock-up splintage seems likely to be effective only in the recent case and may cause healing without lengthening. Mobilization and operative division of the extensor origin seem equally applicable to the acute and to the chronic cases.

PERSONAL CASES

Since 1932 the writer has treated twenty patients with tennis elbow. In two cases the condition was bilateral. The treatment was the same for all except one (Case 1 *) and was given three times a week whenever possible. Occasionally circumstances made it necessary to give treatments only twice a week or less. The average number of treatments per elbow (excluding Case 8) was four.

Only five of the twenty patients got well with a single treatment (compare with Verrall's statement of one-third). Neither the patient's age, nor the length of history, nor the variety of tennis elbow present enables a prognosis to be made of how many treatments will prove necessary, except that the acute type is apt to have a very chronic course. Of the twenty patients with twenty-two tennis elbows only one (Case 8) failed to get complete relief from the writer's treatment.

PATHOLOGY

This is the point on which the least agreement is found. A list has, therefore, been compiled of the various published opinions on this point.

* Treatment in this case consisted of kneading to the muscle bellies, deep friction to the olecranon fossa, and forced extension movements.

The mention of any author's name under a particular heading implies that he considers this pathology *one* of those possible.

1. *Traumatic Periostitis:* Runge [1], Remak [7], Bernhardt [8], Bähr [14], Momburg [23], Blecher [26], Worms [27], Coues [29], v. Goeldel [30], Sourdat [41], Cooke [42], Romer [43], Tavernier [44], Jungmann [47], Fischer [48], Bergmann [49], Carter [50], Bertocchi [51], Merlini [57], Ferrero [58], Frey [59], Fisher [60], Ogilvie [66], Hansson and Horwich [74], Mau [77], Heald [80], Hohmann [85], Boshamer [86], Mennell [87], Tucker [88], Brailsford [90].

2. *Arthritis, Synovitis, Sprain, Adhesions, or Torn Capsule of the Radiohumeral Joint:* Preiser [17], Kaufmann [32], Dubs [38], Glass [65], Ogilvie [66], Jones [70], Trethowan [71], Tucker [88].

3. *Arthritis, Synovitis, Sprain, or Adhesions of the Radio-Ulnar Joint:* Kaufmann [32], Mennell [34], Romer [43], Fisher [60], Trethowan [71].

4. *Displaced, Frayed, Torn, Inflamed, Orbicular Ligament:* Major [3], Coues [29], Romer [43], Mills [56], Ogilvie [66].

5. *Sprained, Torn, Radial Collateral Ligament:* Kaufmann [32], Little [33], Ogilvie [66], Heald [80].

6. *Inflamed or Calcified Radiohumeral Bursa:* Osgood [40], Dittrich [62], Carp [81].

7. *Inflamed or Calcified Subcutaneous Epicondylar Bursa:* Schmitt [39], Fischer [48], Howell [68].

8. *Nipped Synovial Fringe in Radiohumeral or Radio-Ulnar Joints:* Fisher [60], Ogilvie [66], Trethowan [71].

9. *Tear or Fibrositis of Extensor Origin:* Coudere [10], Romer [43], Mairano [45], Fisher [60], Bankart [83], Tucker [88].

10. *Tear or Fibrositis of Supinator Brevis:* Féré [11], Clado [15], Chastenet de Géry [28], Bryce [73], Heald [80].

11. *Torn Pronator Radii Teres:* Morris [2], Little [33], Bailey and Love [89].

12. *Torn Extensor Carpi Radialis Longus:* Rosenburg [52], Ogilvie [66], Heald [80].

13. *Torn Extensor Carpi Radialis Brevis:* Frey [59].

14. *Tear or Fibrositis of Brachioradialis:* Blecher [26], Cooke [42], Romer [43], Gebhardt [84].

15. *Tear, Sprain, Fibrositis of Extensor Digitorum Communis:* Fisher [60], Bankart [83], Mennell [87], Thomsen [91].

16. *Myositis or Tear of Extensor Muscles:* Féré [11], Edgar [63], Hansson and Horwich [74].

17. *Torn Anconeus:* Mennell [34].

18. *Radial Incongruence:* Preiser [22].

19. *Twist of Whole Radius:* Marlin [72].

20. *Rheumatism, Gout, Influenzal Sequelae, Focal Sepsis, Arthritic Diathesis:* Major [3], Duckworth [19], Franke [20], Le Clerc [25], Chastenet de Géry [28], Fischer [48], Frey [59], Edgar [63], Ogilvie [66], Verrall [67], Howell [68], Tucker [88].

21. *Neuritis of Radial, Posterior Interosseous, or Cutaneous Antebrachii Lateralis:* Winckworth [4], O'Sullivan [5], Molle [9], Marshall [18], Seeligmüller [35], Cooke [42].

22. *Saturnism:* Bernhardt [8], Osgood [40].
23. *Osteomalacia:* Mathez [61].
24. *Deposits about Olecranon:* Tucker [88].
25. *Periostalgia:* Frey [59], Conzette [76], Saxl [79].
26. *Osteochrondritis:* Spitzy [75].

COMMENT ON PATHOLOGY

In considering these rival claims, several barely disputed facts must be borne in mind:

1. The onset is gradual;
2. There is no swelling or bruising;
3. A fully developed tennis elbow, once well, does not recur;
4. Except occasionally at the epicondyle, the roentgenogram reveals no abnormality;
5. Only those individuals whose extensor muscles are strengthened by training or use develop the condition;
6. Direct trauma to the epicondyle can cause it;
7. When the elbow joint is opened, no abnormality has been seen except a hyperaemic synovial fringe between the radius and the capitellum;
8. Excluding Osgood's and Trethowan's operations, the only effective treatments are those which relieve the tension on the epicondyle, and even these operations may have this effect, albeit unintentionally.

After these points have been considered, there remain unexcluded only three possibilities:

Affections of the Bursae

That a bursa exists at the lateral epicondyle and can become inflamed or calcified is proved by numerous roentgenograms (Schmitt [39], Carp [81]), by the fluctuating swelling (Carp's Case 5; Howell [68]), by the glairy fluid released at operation (Osgood's [40] Case 2), and by the dramatic cure following bursting the bursa (Carp's Cases 1, 2, 3, and 4). Two different bursae, however, have hitherto been referred to as if they were identical: the subcutaneous bursa and that deep to the conjoined tendon, both of which exist and cause similar symptoms when diseased.

Schreger [93] discovered a bursa which he named the condyloidea humeri externa, the largest example of which was over an inch across. It is described by Gruber [94] as the bursa subcutanea epicondylica. He found its frequency to be once in sixty bodies at one or both elbows, and its maximum size to be one-half an inch by one inch. Vogt [96] and Bardenheuer [97] state that this bursa is the size of a hazelnut and emphasize its liability to inflammation. Again Schmitt [39], who regarded his patient as suffering from a sort of tennis elbow, called the bursa involved by Gruber's name. Fischer [48] also believed disease of the subcutaneous

epicondylar bursa to be a possible cause of tennis elbow. Those patients who have large fluctuating swellings over the lateral epicondyle must be suffering from an affection of this bursa (*e.g.*, Howell's [68] patient).

On the other hand, Monro [92] described but did not name a small bursa, three-eighths of an inch by three-sixteenths of an inch, lying between the common extensor tendon and the head of the radius. Gruber found it once in every six or seven bodies, lying under the extensor radialis brevis just below the epicondyle and in relation to the head of the radius; he called it the bursa musculi radialis externi brevis. This would appear to be the radiohumeral bursa of Osgood [40], Dittrich [62], and Carp [81], which the first named found to be present in eight out of nine dissections; it was small and lay under the conjoined tendon, below the epicondyle and level with the radiohumeral joint line. Grinnell found it in ten of eighteen bodies; it occurred bilaterally in five [81]. Heineke [93] distinguished between the two bursae in frequency and position. It is evident from the size and position of the radiohumeral bursa that fluctuation or an external swelling is not to be expected when this bursa is diseased.

Furthermore, there is a lack of conformity in the interpretation of the roentgenograms. For example, the roentgenograms of Jungmann's [47] and Bergmann's [49] cases of epicondylitis strongly resemble Schmitt's [39] case of a calcified subcutaneous epicondylar bursa and Carp's [81] Case 5 of radiohumeral bursitis; Worms's [27] case of an epicondylar spur over an inch long is very like Carp's Cases 6 and 7 with radiohumeral bursitis.

Nevertheless, the epicondylar spur continuous with the bone and the oblong shadow separate from it form two conditions obviously distinct.

In spite of the positive—and, in the writer's opinion, conclusive—evidence of the existence of the bursae, Trethowan [71] regards the radiohumeral bursa as nothing but a synovial pocket extending upward and outward from the radiohumeral joint toward the epicondyle. Fischer [48] thinks that the gap left when the fibers of the supinator brevis are separated from the capsule of the elbow joint may be mistaken for a bursa. Heald [80] says: "A minor injury of the supinator brevis—possibly involving filaments of the posterior interosseous nerve—near the radiohumeral joint, where the fibres have an intimate attachment to the joint capsule, might well account for the greyish-red nodules of Blundell Bankart, the bursa of Osgood, and the synovial protrusion of Trethowan. . . ."

Bursitis at the epicondyle, however, is a rarity. Osgood's paper in 1922 attracted a good deal of attention, but seven years later only one English case had been reported, and none have been recorded since. Altogether, twelve cases of bursitis have been collected in fourteen years, so that the subcutaneous epicondylar and the radiohumeral bursae can hardly be at fault in more than 1 or 2 per cent. of all the patients with tennis elbow. Moreover, judging by Osgood's account of his own symptoms and those of his patient (Case 3), by the fact that Howell's patient found ample relief from a band around the forearm, and by the complete

and lasting relief afforded to three of Carp's patients by rest and heat in from three to six weeks, bursitis is a mild form of tennis elbow.

Nipping of Inflamed Synovial Fringes

The only published cases are Trethowan's [71]. He opened the elbow in eight chronic cases and found hyperaemic synovial fringes between the radius and the capitellum; their removal was followed by cure. The writer has dissected six normal elbows and found that a long fringe, projecting well into the radiohumeral joint from the posterior part of the capsule, was present in all; anterolaterally this had become a slight ridge. Thus the mere existence of the fringe causes no symptoms; it must be nipped or inflamed before giving rise to disability. The curative effect of the operation does not prove that the removal of the fringe was essential, for the incision into the outer side of the elbow may have divided the taut structures attached to the epicondyle. (See "Comment on Treatment".) A nipping that continues for months and gives rise to symptoms in several positions of a joint with as many movements as the elbow is difficult to picture. In any case, should a non-operative method of freeing the nipped fringe be sought, the writer's manipulation—making, as it does, the radiohumeral joint gape—appears suitable. Nevertheless, it is hard to believe that an inflamed fringe could cause the symptoms of tennis elbow.

Tears of the Extensor Tendon from the Bone and Consequent Periostitis

This view on the pathology is the oldest, has far the greatest number of advocates, and is that favored by the writer. Much evidence points in this direction. Hansson and Horwich [74], experimenting with the gastrocnemius of frogs, found that a muscle tears most easily at its attachment to bone and not at its musculotendinous junction or in the belly itself. Since the position of maximum tenderness must indicate the site of the injury, the lesion in a tennis elbow occurs at the lateral part of the origin of the conjoined tendon from the epicondyle. No swelling or bruising is caused by tendinous ruptures, but crepitation may result and was felt at this point in two of the writer's patients. Further, since cock-up splintage of the wrist, leaving the fingers free, is a successful treatment, it follows that the tear involves the origin of the extensors of the wrist and not of the fingers. The origin of the extensor carpi radialis longus is almost wholly above the epicondyle and that of the extensor carpi ulnaris lies deep to the common extensor of the fingers, while the extensor carpi radialis brevis is the most lateral of the muscles springing from the epicondyle. Therefore, the pathology of the typical variety of tennis elbow is a tear between the tendinous origin of the extensor carpi radialis brevis and the periosteum of the lateral epicondyle. This explains the curative effect of Hohmann's [85] operation in which the origin of only the extensor carpi radialis brevis is divided. Corroboration of this theory is found also in the fact that active extension of the

wrist by a patient with a tennis elbow causes him more pain when it is resisted on the heads of the metacarpals than when the pressure is applied on the tips of the extended fingers.

Tendons usually heal with some lengthening; this explains the freedom from recurrence, since the intact muscles, chiefly the extensor carpi radialis longus, will in future take the greater strain. That the origins of this muscle and of the brachioradialis can be involved as well is suggested by the roentgenograms reproduced by Tavernier [44] and Bertocchi [54]. The gradual onset is explained by the fact that not until healing has begun and there is some adhesion between the torn tendon and the inflamed periosteum does the pull of the muscle cause pain. Then, of course, the inevitable repeated muscular jerks quickly start a chronic periostitis. That such a localized periostitis is not of itself painful is shown by the painlessness of the arm at rest and on passive movement, and by the fact that the epicondyle remains tender for some weeks after complete symptomatic relief has been obtained by the writer's method. The periosteum remains inflamed, but movement is not painful, owing to the separation of the tendon from the periostitic area. This effectual rest allows the inflammation to resolve. In the writer's Case 6, the periostitis was still visible on the roentgenogram six months after symptomatic cure. Moreover, the periostitis set up by a direct injury to the epicondyle may not subside if the extensor muscles are constantly used; whether or not a tear occurs, the condition is a periostitis at the epicondyle maintained by the constant pull of the muscles attached to it.

Proofs that a periostitis occurs are not lacking. It has been seen on the roentgenogram many times: as a spur at the point of the epicondyle from one-eighth of an inch to over an inch long (Blecher [26], Worms [27], v. Goeldel [30], Jungmann [47], Fischer [48], Bergmann [49], Merlini's [57] Case 2, Mau [77], Knoll [82], the writer); as a periosteal thickening running from the epicondyle up the outer side of the shaft of the humerus for two and two and one-half inches (Tavernier [44], Bertocchi [54]); as a series of little spicules of periosteal bone at and below the epicondyle, but extra-articular (Sourdat [41], Merlini's [57] Cases 3 and 4, Ferrero [58]). Hohmann [85], Boshamer [86], Tucker [88], and Brailsford [90] all agree that a periostitis at the epicondyle is sometimes seen, but they do not cite personal instances. As a rule, a periostitis is seen only after months or years of disability, but the roentgenograms of Case 6 show a periostitis at the lateral epicondyle after an injury only four weeks previously, which persisted for six months after symptomatic relief. Sometimes a diagnosis of periostitis is made on roentgenographic appearances that are more probably those of a bursitis.

Microscopy of the excised periosteum has shown definite inflammation (Franke [20], v. Goeldel [30], Merlini [57]); Bergmann [49] removed in addition a piece of the muscle attached to the periosteum, but found evidence of inflammation only in the latter; but in one case Thomsen [91] found evidence of chronic inflammation in an excised strip of the belly of the

extensor digitorum communis. However, in Fischer's [48] Cases 3 and 9, although cure followed periosteal excision, the microscope revealed no abnormality.

The occurrence of a periostitis—visible both on the roentgenogram and at microscopy—in some cases, then, is not in doubt. In the writer's opinion, when the rupture is at its usual site—the tenoperiosteal junction—the subsequent periostitis is not visible on the roentgenogram; it is seen only when an actual tear has taken place in the periosteum as well.

CONCLUSIONS

1. The evidence is overwhelmingly in favor of a typical tennis elbow's being caused primarily by a tear between the tendinous origin of the extensor carpi radialis brevis and the periosteum on the anterior surface of the lateral epicondyle. Secondarily, the continual jerks given to this area of acute traumatic inflammation by muscular contractions set up a chronic periostitis here, and to this the symptoms are referable. The acute periostitis occasioned by a direct injury to the epicondyle can become chronic for the same reason, notwithstanding the absence of a tear. Inflammation of the subcutaneous epicondylar bursa and of the radiohumeral bursa is an uncommon but well-defined entity capable of causing the symptoms of a tennis elbow. Ruptures of a muscle belly are very rare and differ neither in pathology nor in treatment from the same condition elsewhere. The possibility of a nipped synovial fringe's being at fault has yet to be proved.

2. The treatment described—deep friction to the tender area, followed by forced adduction of the extended and supinated forearm—has, in the writer's hands, given complete and lasting relief in an average of four treatments (extremes of one and nine), representing a period of eight to fourteen days. Good results followed the treatment of acute and chronic cases (extremes of thirty-six hours and three years), in the old and in the young (extremes of sixty-one and eighteen years), in a case of periostitis visible on the roentgenogram, and in a case due to direct injury to the epicondyle. The method should be adequate in cases of bursitis where bursting is possible; it is unsuited to muscular ruptures which should be treated on general lines,—*i.e.*, by kneading and stretching the belly involved.

3. Mobilization is theoretically justifiable in all cases of typical tennis elbow, because the tendon is thereby pulled off the chronically inflamed epicondylar periosteum to which it is adherent; thus the latter is spared the continual minor traumata which are maintaining the periostitis. Once this is effected, complete symptomatic relief will follow, even though the inflammation at the epicondyle has not yet subsided. Moreover, the writer's treatment is the most convenient from the patient's point of view,—it takes only fifteen minutes every other day; it needs no anaesthetic; and it in no way interferes with the patient's ordinary activities.

Furthermore, since healing with permanent lengthening is insured by this method, recurrence is most improbable.

4. Failing mobilization, the best treatment for the recent case appears to be a simple cock-up splint worn on the wrist day and night. In three-quarters of the cases complete relief may be expected in an average of a month's time. The success of this method depends on the relaxation it insures of the extensor carpi radialis brevis, whereby its tendon of origin and the epicondylar periosteum are kept in apposition and allowed to heal together without interruption.

5. All the operations described—on whatever theory they are based—are successful whether or not the elbow joint is opened. Of these, simple division of the origin of the extensor carpi radialis brevis from the bone seems the easiest and the best. Operation is equally indicated in acute and in chronic cases, but appears not to give results superior to the writer's method, since the mere healing of the incision is bound to occupy a fortnight of the patient's time.

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BONE METABOLISM: ITS PRINCIPLES AND ITS RELATIONS TO ORTHOPAEDIC SURGERY*

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Within the past ten years there has been published on the subject of bone metabolism a vast amount of data discovered through research and by clinical observation. The study of this subject is a natural development in the field of physiological chemistry and its details and minutiae are outside the knowledge and beyond the comprehension of the average orthopaedic surgeon. However, the clinician who treats diseases of bone must have a clear, if simplified, understanding of normal and of pathological bone metabolism, as well as a definite working method of treating bone lesions which are due to its disorders. He may make use of the facts which emanate from the laboratories of physics and chemistry, without pretending to the exact knowledge of the scientists who discovered them.

While much progress has been made in this particular branch of medical science, there are yet many statements as to facts and to their proper interpretation which are under dispute. The authors of this paper, which is written for the practical guidance of the orthopaedic surgeon, do not attempt to present this subject in detail nor to discuss controversial matters, but to state the principles of bone metabolism which are generally accepted and to demonstrate that certain methods of treatment are logical and effective.

NORMAL METABOLISM OF BONE

Bones are not inert substances. At all times they are physiologically active and particularly so during the period of growth. They are highly sensitive to local conditions, such as injury and infection, that may affect their normal blood supply and nutrition, and they react promptly to many conditions, such as malnutrition and anaemia, that affect the general metabolism of the body. The substances that constitute bone must not be understood to be fixed, but to be in a constant flux, as are the substances of all living tissues.

An adequate supply of calcium, phosphorus, magnesium, and other elements is necessary for normal metabolism of bone. These elements are brought to the bones by the blood serum which may be viewed as a saturated solution of calcium and phosphorus in a balanced ratio of 10 units of the former to 4 of the latter.

Normal plasma calcium concentration depends primarily on adequate supply of calcium in the food, on the pH of the intestinal contents, on the presence of phosphorus and magnesium, and on an adequate supply of

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vitamin D. If there be a paucity of the last in the food, it may be compensated by ultra-violet radiation of the body, either natural or artificial.

Calcium is absorbed from the intestinal canal as soluble phosphates and other compounds. The optimal absorption is attained by a dietary ratio of approximately three parts of calcium to five parts of phosphorus, as an excess of either element leads to the formation of insoluble compounds which are thrown off in the faeces.

An acidity of the intestinal contents aids in this absorption.

Vitamin D may aid in the absorption even in the presence of an imbalanced diet and in the absence of intestinal acidity. This substance is found in animal fats—such as cod-liver oil, butter, and milk—in eggs, in green vegetables, etc. It is synthesized in the laboratory from ergosterol and in the body from cholesterol by the action of the ultra-violet rays.

The maintenance of normal concentration of calcium and phosphorus in the blood is essential to the vital activity of all structures of the body. For instance, its relation to muscle tone and nerve irritability is well exemplified in tetany.

The level of concentration is controlled by vitamin D and by the secretions of the ductless glands, particularly of the parathyroid, although in a quite dissimilar manner. However, the solubility of calcium and phosphorus is associated with the presence of magnesium.

Vitamin D, when insufficiently opposed by parathormone, tends to raise the blood phosphorus and the blood calcium. Parathormone insufficiently opposed by vitamin D lowers the blood phosphorus and raises the blood calcium. Each exerts an inhibiting action on the other, and by their combined activity they maintain a normal blood concentration of calcium and phosphorus.

FIG. 1

Case C. P. Osteitis fibrosa cystica. Roentgenogram of tibiae, April 22, 1932.

The local factors which influence bone metabolism are: (1) the hydrogen-ion concentration and the carbon-dioxide tension of the plasma; (2) the presence of substances which may influence the solubility of calcium phosphate, such as proteins and the salts of magnesium; and (3) phosphatase and possibly other as yet unrecognized enzymes. These local factors may be activated or altered by conditions which affect the local blood supply, such as bone injury and infections and general toxaemias.

Phosphatase, an important local factor, is an enzyme which causes hydrolysis of hexose phosphate, with the liberation of phosphorus. It is

found in bone, blood serum, the kidneys, the intestines, and other tissues. It acts best in an alkaline medium and possibly in the presence of a co-enzyme or of an activator such as magnesium. It is thought to be synthesized by the cartilage cells in growing bone and by the osteoblasts. The amount found normally in the blood serum is from 1.5 to 4 units per 100 cubic centimeters in adults and from 5 to 12 units in children.

There is usually an abnormal increase in the blood phosphatase in certain bone diseases—notably rickets, osteitis deformans, and osteitis cystica fibrosa—but it is also increased in certain diseases of the liver with jaundice. The significance of these facts is not clearly understood.

DISEASES OF BONE CHARACTERIZED BY DISTURBANCE OF CALCIUM AND PHOSPHORUS METABOLISM

Generalized Osteitis Fibrosa Cystica, Recklinghausen's Disease

This symptom-complex is characterized by a high-calcium, a low-phosphorus, and a high-phosphatase content of the blood serum. The intake-output calcium and phosphorus balance is negative,—*i.e.*, the output is greater than the intake. Normal excretion of calcium occurs through the lower bowel and through the kidneys in a relation of approximately nine parts through the former to one part through the latter. The increased loss which occurs in Recklinghausen's disease takes place largely through the kidneys, so that the above ratio is greatly reduced and may even be reversed. If the kidney function becomes impaired, there is a compensatory increase in the excretion by the bowel.

FIG. 2

Case C. P. Roentgenogram of tibiae, June 10, 1932. Note increased calcification, especially in the cystic areas. Patient on a high-calcium, high-phosphorus, and high-vitamin-D diet.

FIG. 3

Case C. P. Roentgenogram of tibiae, February 14, 1934. Note that there is practically complete calcification of the cystic areas. Normal areas also show increased deposition of the bone salts.

The rapid loss of minerals from the body tends to bring about a generalized bone decalcification, or osteoporosis. Spontaneous fractures are frequent in advanced cases.

In another clinical type, the classical one, the demineralization of bone is accompanied by the formation of numerous cysts and giant-cell tumors. These must not be confused with the solitary multilocular bone cysts and the giant-cell tumors sometimes found in bones and in no way related to Recklinghausen's disease. The former can be readily distinguished from the latter by their multiplicity, by their different histological formation as seen by the microscope, by their different location in the bones, and by the fact that they are associated with the generalized bone resorption and the typical blood changes of Recklinghausen's disease.

In a third type of this disease, called the metastatic type, the symptoms which have been described are associated with calcium deposition in the kidneys and in other soft tissues. This type is not readily distinguished from so called renal rickets. These three clinical forms probably represent only different stages and phases of this disease.

Other symptoms which characterize generalized osteitis fibrosa cystica are bone and joint pains, a decreased response of the neuromuscular system to stimuli, with muscular weakness at times very marked, gastro-intestinal disturbances, polyuria and polydipsia, loss of weight, and anaemia.

It is now generally accepted that this symptom-complex results from the hypersecretion of one or more of the parathyroid glands. This view is based on clinical observation and on an enormous amount of research work. More than 100 parathyroidectomies have been performed for the relief of the symptoms of this disease entity since Mandl in 1926 did the first one. Improvement in the patient's condition, often striking and almost immediate, usually follows the operation. The blood picture of Recklinghausen's disease has been reproduced in animals by injections of the parathyroid hormone. These and other studies have also helped to clarify the entire subject of calcium metabolism. Finally, Jaffe, Bodansky, Blair, and others, by injections of parathormone into susceptible animals, have produced histological lesions in the bones that are identical in many respects with those seen in Recklinghausen's disease.

THE MODUS OPERANDI

The physiochemical method by which parathormone regulates calcium and phosphorus metabolism is not entirely understood. Certain facts, however, have been definitely established.

Hyperparathyroidism

There is an increased output of urine and of the electrolytes of sodium, chlorine, etc., which it contains. Accompanying this diuresis, there is an increase in the excretion of soluble calcium phosphates through the kidneys. One reason for this is the fact that a larger quantity of urine with its contained electrolytes naturally carries with it in solution a greater

FIG. 4-A FIG. 4-B

Fig. 4-A: Case C. P. Appearance of right femur on admission, April 22, 1932.

Fig. 4-B: Case C. P. Right femur, February 24, 1934. Patient on high-calcium, high-phosphorus, and high-vitamin-D diet. Note improvement in calcification, especially in the appearance of the cyst wall.

FIG. 5

Case C. P. April 22, 1933. Giant-cell tumor of the right femur.

FIG. 6

Case C. P. A later view of giant-cell tumor shown in Fig. 5.

quantity of salts. Furthermore, there appears to be an increased solubility of calcium and phosphorus both in the body fluids and in the urine owing to a slight increase in magnesium concentration and to a moderate shift of the pH to the acid side.

Parathormone increases solubility of calcium phosphate in the blood. Its first action appears to be a phosphate diuresis, causing a reduction of inorganic phosphorus in the blood. This, in turn, increases the activity of the calcions in the blood and then there is an actual increase in total calcium concentration. Bone salts flow into the blood because of a change in the equilibrium between solids and fluids. Excess of ions (soluble electrolytes) is probably the chief factor in the increased solubility of the blood and of the urine. In other words, an increase of water, magnesium, sodium, and chlorine in the circulating fluids about the bones causes a shift of calcium phosphate from the bones to the fluids.

FIG. 7-A FIG. 7-B

Fig. 7-A: Case C. P. October 1932. Patient on high-calcium, high-phosphorus, and high-vitamin-D diet. Note shell in large giant-cell tumor, also evidence of increased general calcification.

Fig. 7-B: Case C. P. January 31, 1933. Patient on high-calcium and high-phosphorus diet. Vitamin D has been dropped since date of Fig. 7-A. Note loss of shell of giant-cell tumor, but there is still a general increase in calcification.

Following decalcification, or halisteresis, osteoclasts proliferate and act as phagocytes on decalcified bone matrix. Fibrosis and the formation of giant-cell tumors occur during the process.

Hypoparathyroidism

There is an inability to excrete excess phosphorus by urine. The output of urine is decreased. The phosphorus unites with cations of calcium, strontium, magnesium, etc., to make insoluble phosphates which are excreted through the colon. The calcium in the blood, therefore, is lowered, while the phosphorus is high. Symptoms of tetany may appear. Various forms of treatment may be used to control this:

1. Administration of sodium chloride causes diuresis and increased solubility of calcium phosphate in the

urine by electrolytic action and an increased amount of water.

2. Ingestion of an increased amount of calcium speeds up the elimination of phosphorus in the faeces and allows a larger remainder of calcium for the body.

3. Injection of parathormone increases the amount of urine and the solubility of calcium and phosphorus.

4. Administration of magnesium may also control the manifestations of tetany.

FIG. 8
Case C. P.: Roentgenogram of skull, April 23, 1932.

FIG. 9
Case C. P.: Roentgenogram of skull, April 3, 1933.

Renal Rickets

This condition closely resembles generalized osteitis fibrosa. It is believed that primary damage to the kidneys is the first and basic factor in the development of this disease. Renal elimination becomes impaired. There is a retention of phosphorus in the body, although a portion of the excess is excreted through the lower bowel in the form of insoluble calcium phosphates. There takes place a physiological stimulation of the parathyroid glands to aid in the elimination of phosphorus. Hyperplasia of these glands follows. General decalcification of bones occurs. This decalcification has been attributed to various causes: (1) persistent chronic acidosis; (2) retention of electrolytes and non-protein nitrogen which increase the solubility of calcium phosphate; (3) overactivity of the parathyroid glands; and (4) loss of calcium by the colon in the form of insoluble phosphates. Calcification occurs in the kidneys, due possibly

to a change in the solubility of calcium in the urine and to an alteration in the damaged kidney tissues, which favors local deposit.

It is apparent therefore, that when this complete picture of hyperparathyroidism and kidney calcification is developed, a differentiation of the two diseases may be made only by discovering the history of renal damage that preceded the skeletal changes. That the retention of phosphorus in the body may cause hyperplasia of the parathyroid glands is supported by the experimental evidence that such hyperplasia may be produced by a diet which is excessive in phosphorus.

True or primary hyperparathyroidism differs, therefore, from renal rickets in that a true secreting parathyroid adenoma is the cause of the former, while in the latter the parathyroid hyperplasia is a secondary development due to kidney damage. It may be possible that when this hyperplasia has become established it passes the limits of a physiological process and becomes pathological.

TREATMENT

Parathyroidectomy

If in true hyperparathyroidism the primary fault is an excessive hormone secretion from the parathyroid glands due to a secreting adenoma, it would appear logical to diminish the secretion by removing the adenoma. Many cases have undoubtedly been improved by parathyroidectomy, particularly those in which a true adenoma has been found and removed. Some cases have not been improved by operation, probably because the adenoma was not found and only normal parathyroid glands were removed. The danger of tetany must be borne in mind and guarded against.

Irradiation

This method of treatment may accomplish the same results as are obtained by operation.

Diet

By diet alone the symptoms of hyperparathyroidism may be controlled. Since there has been an enormous loss of both calcium and phosphorus from the body, it is primarily essential that they be replaced through the diet. It is evident that this replacement is necessary even though the disease has been controlled by parathyroidectomy. When it has not been so controlled, it is essential to give sufficient quantities, not only to replace the loss that has already occurred, but to compensate for the continued loss that occurs through the overactivity of the parathyroids. This is accomplished by giving foods such as milk, cheese, meats (including fish), which have a high content of calcium and phosphorus, and, if necessary, by adding to the diet calcium and phosphorus salts. The calcium may be administered as a chloride, carbonate, lactate, or gluconate; the phosphorus as the monosodium or the disodium phosphate. However, dicalcium phosphate, which combines both elements in one compound, answers the purpose and preserves the normal ratio of calcium

and phosphorus which should at all times be maintained in diet. They must be given in sufficient quantities—*e.g.*, two to seven grams of dicalcium phosphate—to produce and to maintain a positive intake-output balance—*i.e.*, the intake through the food should exceed the output through the urine and faeces by approximately one gram of each per day. If laboratory studies of this balance cannot be made, an approximate index of a positive balance will be found in increasing bone calcification, as shown in roentgenograms, and in an approach of the blood chemistry toward the normal. Increased bone calcification has been noted in five weeks after the beginning of treatment.

The administration of vitamin D in large amounts is essential. Thirty to sixty drops of 250 D viosterol (10,000 D per gram) is adequate, the amount given being dependent on the severity of the symptoms of the disease. The vitamin D probably is antagonistic to the action of parathormone; it aids in deposition of calcium and phosphorus in the bones; and it aids in absorption from the intestinal tract.

Many writers have spoken of the danger of producing metastatic calcification if a high-calcium, high-phosphorous, and high-vitamin-D intake is pushed. In a case treated by the authors, which is reported in full at the close of this paper, a high intake has been maintained for four years with a remarkable degree of bone healing and without evidence of any kidney damage. In fact, the only period during which the patient has had any kidney dysfunction occurred at a time about two years ago when, because of an automobile accident, she was admitted to another hospital for three months. There she was given a diet high in phosphorus and low in calcium and in vitamin D. When she returned to our care at the end of this time she showed evidence of kidney damage and bone decalcification. Her balanced diet was restored; the kidney function returned to normal;

FIG. 10-A FIG. 10-B

Fig. 10-A: Paget's disease, showing femur before magnesium therapy.

Fig. 10-B: Same case as shown in Fig. 10-A after six weeks of magnesium therapy. Note decalcification.

bone calcification increased; and she has been quite well since that time.

The entire subject of nephrolithiasis is not yet fully understood or entirely settled. In primary hyperparathyroidism there is an excessive excretion of calcium and of phosphorus through the kidneys due, as already stated, to the fact that the amount of urine and the solubility of calcium and phosphorus are increased. An increased solubility would reasonably be expected to lessen the danger of stone formation even if associated with kidney hyperfunction. If the solubility is lessened by insufficient intake of water, of sodium chloride, and of other substances which have direct bearing on solubility, precipitation of calcium phosphate may occur. In renal rickets the kidneys have at some previous time suffered damage and calcification is common, not because of hyperfunction, but because of dysfunction. There is parathyroid hyperplasia which tends to increase the solubility of calcium in the body fluids, as in true or primary hyperparathyroidism, but, in spite of this, kidney calcification occurs. It would appear, therefore, that kidney damage is an important factor in the production of stone. Furthermore, nephrolithiasis occurs in individuals who are not suffering, so far as is known, from any chronic bone resorptive lesions and who have no disturbance of their calcium metabolism.

Therefore, does it not seem reasonable that, if in primary Recklinghausen's disease we increase the intake of calcium and of phosphorus

FIG. 11

Paget's disease, showing pelvis. Note occlusion of the joint cleft and also the exostosis at the lower border of the left acetabulum.

to balance or even slightly to exceed the output, and if at the same time we give vitamin D which aids in bone calcification, the first deposition of these elements should be in those structures (the bones) where such a deposit normally occurs and which are calcium hungry? Stated in another way, if vitamin D, contrary to parathormone, lessens the solubility of calcium salts in the body fluids, is it not reasonable to suppose that an excess of calcium in the blood serum will be deposited in the normal storehouse in the bones instead of in the soft tissues? Furthermore, even if a part of this excess cannot be so assimilated, why should not the kidneys and the lower bowel be able to take care of it as they do in a normal individual who has ingested more calcium than the body can use?

In *renal rickets*, in which there is a primary retention of phosphorus and a secondary loss of calcium, it would seem reasonable to raise the calcium intake and to keep the phosphorus intake low. This plan of treatment is further justified by the experimental observation that a low-calcium diet may produce a condition closely resembling renal rickets. Vitamin D should be given in moderate doses to assist in recalcification and to antagonize the hypersecretion of parathormone.

There are some authorities who believe that parathyroidectomy is indicated where there is kidney damage, so that a smaller intake of

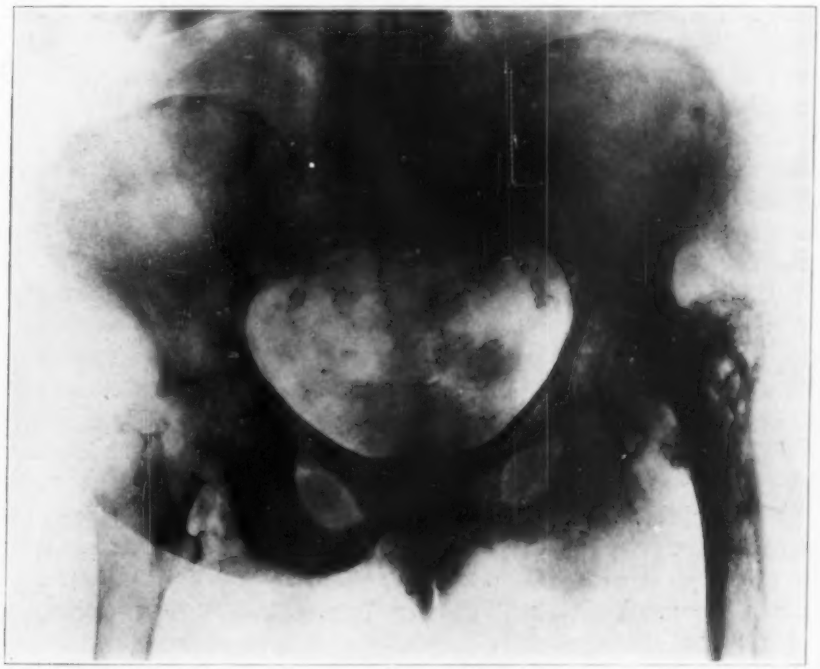

FIG. 12

Same case as shown in Fig. 11 after six weeks of magnesium therapy. Note decalcification and the disappearance of the exostosis and the reappearance of the joint cleft.

calcium, of phosphorus, and of vitamin D would serve to keep the patient in balance. Surgical operation is certainly a reasonable procedure if the parathyroid hyperplasia exceeds the physiological limits and has become pathological.

Osteogenesis imperfecta is probably due to a congenital defect and is not associated with parathyroid dysfunction. One case has been under the observation of the authors for six years. This patient has been treated with thymus gland, with thymus extract plus high-calcium, high-phosphorus, and high-vitamin-D diet, and with thymus extract alone at different periods. Also, careful studies of her blood chemistry, of her intake and output, and of the roentgenographic appearance of her skeleton have been made. No marked change and no lasting improvement have resulted from any of these means of treatment. Possibly the fact that this disease appears to undergo phases of progression and recession accounts for apparent improvement under various methods of treatment, which has been followed by a relapse.

Rickets and osteomalacia of the low-phosphorus type, which is the ordinary form, are caused by a reduction in the lime salts, but with a relatively low-phosphorus, high-calcium, and low-vitamin-D intake. It is apparent that the treatment consists merely in supplying vitamin D and in giving adequate amounts of phosphorus and of calcium in balanced normal ratio. It can be seen that, since the bone change is produced on a diet relatively low in phosphorus, there is no call for parathormone hypersecretion, and, therefore, one would not expect to find hyperplastic parathyroids.

Paget's disease is associated with certain metabolic changes. It is characterized by definite well known roentgenographic changes and deformities of bones and by certain clinical manifestations, such as bone pains, local tenderness and elevation of temperature, particularly noted in the tibia, joint stiffness, and myotonia.

The blood chemistry is normal except for a high-phosphatase content of 12 units and upward. Balance study indicates a moderate retention of calcium and of phosphorus, which may vary in degree, and often a retention of magnesium and a loss of sulphur. There is no evidence to connect this disease with disorders of the parathyroid.

The following treatment, adapted from Dr. Laslo Kajdi's treatment of juvenile hyperostosis, has been found by the authors, in collaboration with Dr. Kajdi and Dr. Corson White, to be beneficial. It consists in the use of a diet low in calcium, low in phosphorus, and high in magnesium. The last is given as magnesium carbonate in dosages of from four to ten grams per day. Each month a study of the blood phosphatase and magnesium is made; of the former to check the progress of the patient, and of the latter to avoid the danger of magnesium toxicity which might occur if kidney function became impaired for any reason. Every six months a balance study is made.

The efficiency of the treatment is indicated by a lessening of calcium

and of phosphorus retention, by a decrease in the blood phosphatase, by a decrease in the density and in the diameter of the long bones, by a subsidence or disappearance of such symptoms as pain, local tenderness and heat, stiffness, and fatigue, and at times by a definite improvement in kidney function. It seems probable that the use of magnesium exerts a favorable influence in Paget's disease, because it increases the solubility of calcium and of phosphorus, as stated in a preceding paragraph, and because it acts as a vasodilator. In chronic hypertrophic arthritis the use of magnesium was suggested by Dr. Mitchell Rubin and has been carried out by one of the authors (I. S.), in collaboration with Dr. Corson White, with what appear to be favorable results in selected cases.

A calcifying diet might be found useful in bone lesions which are not essentially metabolic, such as tuberculosis, widespread myeloma, major fractures, etc.

The authors have been making observations as to the usefulness of such a diet in tuberculosis of bone, but they are unable as yet to publish any definite conclusions.

In atrophic arthritis with generalized bone atrophy it may be found that the employment of the principles of calcification will aid in restoration of normal metabolism of the bones. This would appear to be a fruitful field for observation and research.

Heretofore, attention has been focussed largely on normal calcification and calcifying regimens. It is evident, however, that, in enumerating the principles of calcification, the causes of decalcification are obvious.

Decalcification may be caused: (1) by an inadequate dietary and vitamin intake, low-calcium and high-phosphorus or low-phosphorus and high-calcium, with low-vitamin-D in both; (2) by hypersecretion of parathormone; (3) by the administration of such elements as magnesium and strontium; and, (4) by physiological processes attendant upon prolonged fixation of an extremity in a plaster cast, upon paralysis, and upon muscle atrophies, etc.

The work of Nachlas and Shelling in producing softening of bones for the purpose of correcting rachitic deformities is well known. For this purpose they have employed strontium, which has a higher decalcifying power than magnesium.

In considering this question of diet therapy, it should be borne in mind that the following foods have a high-calcium and high-phosphorus content: milk, cheese, eggs, meat, sea food, peas, beans, nuts, plums, peaches, prunes, and apricots. They are to be given in generous quantities in a calcifying diet and are to be omitted in a decalcifying diet. The addition of dicalcium phosphate and viosterol D, as previously mentioned, is essential for production of rapid calcification.

CASE REPORT

C. P., a white female, aged thirty-one years, was admitted to the Orthopaedic Hospital on April 21, 1932, on the Service of Dr. A. Bruce Gill.

The family history was negative.

The patient had been well until the age of twenty. She had then married and had immediately become pregnant. On March 14, 1920, she had noticed a small growth on the alveolar margin of the mandible. Roentgenographic diagnosis was as follows: "A large area of bone absorption between the first bicuspid and second molar, thinning of the mandible, sarcoma of the mandible." At operation in a hospital in Hartford, Connecticut, a giant-cell tumor was removed. Thirteen x-ray treatments were given after the operation. The pregnancy went to term, and the baby died in convulsions a few days after birth.

In 1927 the patient had begun to suffer from severe indigestion, with gastric pain and vomiting. Pain in the legs and in the arms had developed, and later in the same year a gastro-enterostomy had been performed in a Philadelphia hospital with relief from indigestion. However, pain in the extremities had continued and had increased, and the patient had lost weight.

In September 1927 a tumor had developed on the maxilla and another on the left malar bone. The latter tumor had been removed in August 1928. In September 1928, when struck by a revolving door, the patient had suffered a fracture of the left femur. She had been treated in a Philadelphia hospital for two months and then had been sent home with non-union of the fracture. She did not walk again until after treatment in the Orthopaedic Hospital in 1932.

The patient had next noticed a tumor developing in the left tibia. In January 1929 she had fractured her right femur in attempting to change her position in bed.

On March 20, 1930, two parathyroid glands had been removed from the left side in the Jefferson Hospital. Histological examination of the specimen had showed normal parathyroid tissue and a small nodule of thyroid gland. At this time the blood calcium was twelve and seven-tenths milligrams and the phosphorus was one and seven-tenths milligrams. There was noted local pain and heat in the tibial tumor.

On September 1, 1930, an operation had been performed for an abscess on the broad ligament. In January 1931 the patient had been placed on a high-calcium diet with cod-liver oil. She had been discharged from Jefferson Hospital on May 6, 1931, feeling more comfortable, but showing no other improvement.

On admission to the Orthopaedic Hospital in April 1932, the laboratory report was as follows:

Red blood cells—3,370,000
Hemoglobin—60 per cent.
Color index—0.9
White blood cells—5,900
Calcium—14 milligrams per 100 cubic centimeters of blood
Phosphorus—3.2 milligrams per 100 cubic centimeters of blood

The urinalysis showed specific gravity of 1.010 with alkaline reaction. Albumin, red blood cells, and pus cells were present, but Bence-Jones bodies were absent. The phenolsulphonphthalein test gave 55 per cent. in three hours.

The patient had not walked for almost four years. There was marked muscular weakness and she was unable to move her legs. Numerous tumors were present, particularly one of the left tibia and a massive one of the upper portion of the right femur. The fractures had healed, but she complained of pain in the legs.

On April 28, 1932, she was placed on a high-calcium, high-phosphorus, and high-viosterol diet,—six to seven grams of calcium and phosphorus a day, and increasing doses of viosterol up to sixty drops per day. On June 10, 1932, there was definite roentgenographic evidence of increased calcification of the bones.

On June 13, 1932, two parathyroid glands were removed from the right side of the neck. Microscopic examination of these glands showed considerable fatty infiltration, with evidence of oxyphilic cells, but with comparatively few principal cells.

On June 20, 1932, the blood calcium was eight and eight-tenths milligrams and the

phosphorus was three and fifteen-hundredths milligrams. The patient felt stronger and was free from pain. She was allowed up in a wheel chair for the first time.

The diet was continued with some variations from time to time in ratio of calcium and phosphorus.

On August 24, 1932, the patient was fitted with braces and was able to stand up. She was discharged from the hospital on October 9, 1932, walking with braces and crutches.

In November 1932, the viosterol was dropped from the diet and, by January 1933, the patient had suffered some decalcification. The viosterol was then restored to her diet, and by March she had regained what had been lost. In February 1933, she was able to discontinue the use of the braces and to do her housework for the first time in more than five years. During this period of her treatment her intake-output balance studies indicated an average daily retention of more than two grams of calcium.

In May 1933, an attempt was made to lower the intake of calcium, phosphorus, and vitamin D, but it was found that she could not be kept in balance unless the viosterol 250 D was maintained at sixty drops and the calcium and phosphorus at six grams a day.

In July 1934, the patient had an automobile accident and suffered fractures of both bones of the right forearm, of the right femoral neck, of three ribs, and of the right humerus. She was admitted to another hospital for three months, where she was kept on an incorrect diet of low-calcium, high-phosphorus, and high-viosterol intake. The result was decalcification and kidney damage. The latter was indicated by a drop in the phenolsulphonephthalein from 70 per cent. to 30 per cent., by an increase in the non-protein nitrogen to above 60 milligrams per 100 cubic centimeters, and by the marked presence of albumin and of hyaline and granular casts. The patient was readmitted to the Orthopaedic Hospital. The fractures were ununited; the blood calcium was high and the blood phosphorus low, and the patient was in negative balance. Her diet was corrected by putting her on a high-calcium, high-phosphorus, and high-vitamin-D intake. The ununited fractures healed and she again began to have increasing calcification of bone. Since that time she has been well. Her blood chemistry is normal. Her blood phosphatase was originally 18 to 20, and is now 1.5 to 2.5.*

This very interesting and instructive case demonstrates numerous facts mentioned in this paper. If we assume that this patient had a primary parathyroid adenoma, she still has it. While three parathyroid glands have been removed, they were definitely atrophic in type, and their removal did not control her condition.

Definite control and improvement have been secured only through a high-calcium, high-phosphorus, and high-vitamin-D diet. The blood chemistry is now normal and the blood phosphatase has fallen to normal levels. The balance studies are positive, showing an average retention of at least two grams a day. The bones have calcified and pain has ceased. Muscular strength has improved and the patient can now walk without braces and crutches.

Her only kidney dysfunction developed during a period of incorrect diet and disappeared as soon as the balance of phosphorus and calcium intake was restored to the normal ratio of five to three.

The authors have offered this paper with the object of clarifying this subject of bone metabolism in the minds of many orthopaedic surgeons,

* We are indebted to Dr. Corson White for the laboratory work done in this case and for her collaboration in carrying out the treatment, and to Dr. Ralph Bromer for his careful roentgenographic studies.

and of stimulating their interest in bone diseases characterized by a disturbance of bone metabolism. A number of promising fields of research and of clinical observation seem to be opening up before us. We must be careful, however, not to apply methods of calcification and decalcification indiscriminately and thoughtlessly, but only after careful observation and sound reasoning. Final conclusions must be reached slowly after oft repeated experiments, and as a result of accumulated knowledge. It must be borne in mind that this entire branch of medical science is still in its infancy and that its basic facts and principles are discovered by the physiological chemist, but that the orthopaedic surgeon may assist in the development of our knowledge by careful clinical observations.

The authors are particularly indebted to the work and writings of Dr. David Shelling and they recommend to the reader his recent book.[1]

1. Shelling, David H.: The Parathyroids in Health and in Disease. St. Louis, C. V. Mosby Co., 1935.

METABOLIC STUDIES IN OSTEOCHONDRITIS OF THE CAPITAL FEMORAL EPIPHYSIS

BY LYMAN A. CAVANAUGH, M.D., AND E. KOST SHELTON, M.D., SANTA BARBARA, CALIFORNIA, AND ROSS SUTHERLAND, M.D., LOS ANGELES, CALIFORNIA

Although recognized in comparatively recent years, nevertheless osteochondritis of the capital femoral epiphysis has an extensive literature. The disease was originally described by Legg in 1909 as "an obscure affection of the hip joint", and independently by Calvé and Perthes in 1910. However, it was Perthes (1913) who first gave a clear-cut description of the clinical course, the roentgenographic findings, and the pathology. The accumulated literature consists principally of discussions of the possible etiology and pathology with certain suggested refinements in treatment. Certainly a step in advance has been the recognition that osteochondritis of all growth or epiphyseal centers is probably one and the same disorder. There is as yet, however, no clear-cut concept of the disease, of its etiology, or of its underlying pathology.

Perthes' classical description of the pathology as exemplified by a single case in 1913 has not been materially changed. Numerous other studies of tissue removed from the epiphysis and the diaphysis during the active course of the disease have been reported. Most of these investigators have not differed materially from Perthes' original description. The variations as regards the description of tissue examined will have to be considered in the light of a series of well-controlled observations before a clear concept of the pathology will be possible.

The etiology of this disease has been a subject of controversy since the original work of Legg, Calvé, and Perthes. A considerable number of causative factors have been suggested. These include infection, syphilis, congenital anomaly, osteomalacia and rickets, endocrine imbalance, undiagnosed congenital dislocation of the hip, alterations in calcium and phosphorous metabolism, trauma or trauma with secondary circulatory disturbances, and arrested or inferior development in the epiphysis affected. The last will receive further consideration.

Most recent investigators are agreed that osteochondritis of all epiphyseal centers is one and the same process with a common etiology. If this is true, there is very little reason to believe that any one of the aforementioned etiological factors is the sole explanation of a picture as typical as that of osteochondritis. Overton suggests insufficient nutrition of the epiphysis as the etiological factor. This seems to be approaching a more tenable concept. The question immediately arises, however, as to what factor or factors are responsible for the disturbed nutrition.

In regard to arrested or inferior development of the epiphysis affected, Gonzales-Aquilar cites Lawen and Seemen as having described several forms of pathological chondral ossification in conjunction with alterations

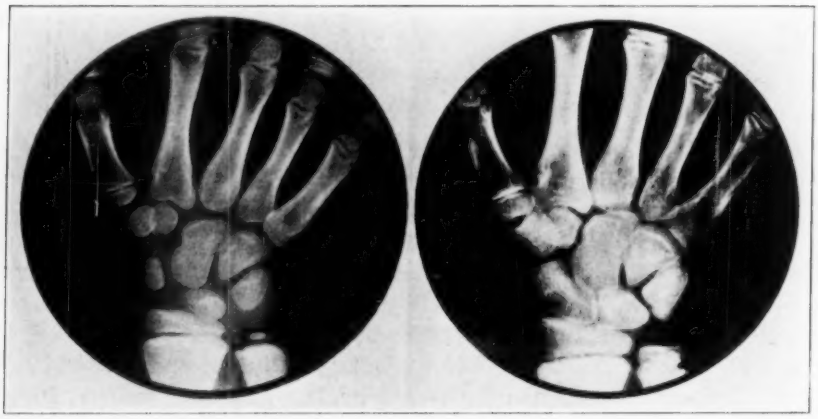

FIG. 1

Case 1. R. T. Patient's wrist (left) compared to approximate normal for age.

in function of the thyroid. Nagasaka, reporting on the histological study of eight cases, cited lateness and abnormality in endochondral ossification as consistent observations. Kehl felt that an abnormality in development, combined with trauma, was the cause. Hilgenreiner

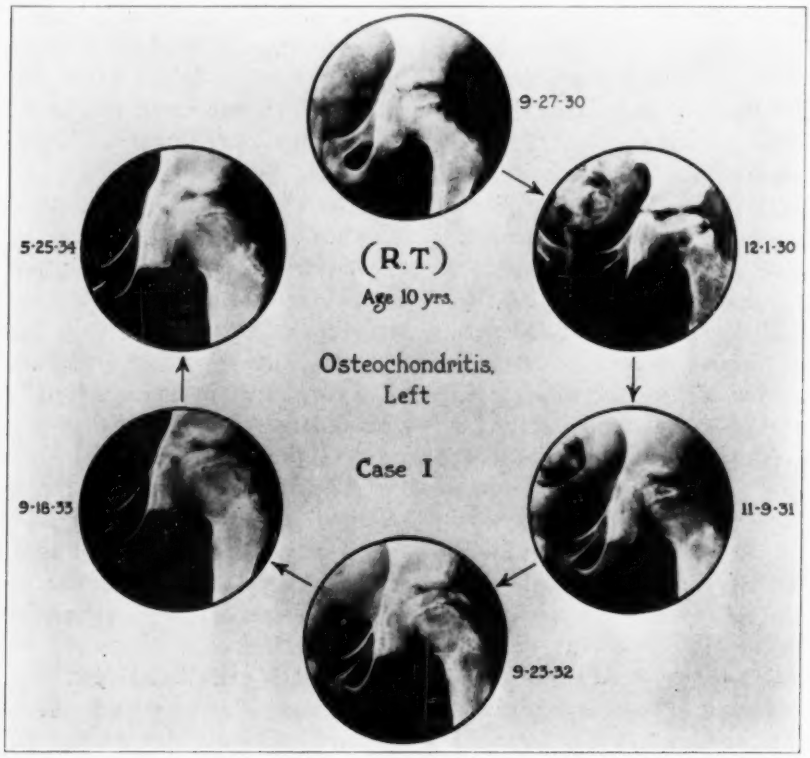

FIG. 2

mentioned instances where considerable retardation in development of the affected epiphysis was noted prior to the onset of osteochondritis, and he suggested this local disturbance as the cause. Apparently none of these authors has investigated the degree of ossification in other epiphyseal centers.

The purpose of this paper is to present a study of five unselected and uncomplicated cases * of osteochondritis of the capital femoral epiphysis, in all of which there is definite evidence of a metabolic deficiency.

In order to avoid repetition, the negative findings in the following cases, with a few exceptions, will be considered *en masse*. In no instance was there a history of other cases of osteochondritis in the family. Physical examination revealed nothing abnormal in the heart, lungs, or abdomen. The hemoglobin, red and white cell count, differential count, and urine were normal in each case. The blood Wassermann and the Von Pirquet tests were negative in all cases. The serum calcium and phosphorous were obtained only in Cases 1 and 3, and they were normal in both. Stool examinations were negative.

All patients received supervised physiotherapy, consisting of pool exercise regularly, to prevent disuse atrophy. Inasmuch as the Clinic offers school facilities for all orthopaedic cases in addition to the medical, surgical, and physiotherapeutic services, it can readily be seen that all patients have been under close observation.

CASE REPORTS

CASE 1. R. T., a white male, aged ten years, was admitted in September 1930. He complained of pain in the left hip and a limp of three months' duration. There had been no known trauma. Physical and roentgenographic findings were consistent with osteochondritis. Treatment for the first fifteen months consisted of a Bradford abduction-traction brace which was replaced by a cast at the end of four months. Continuous retrograde changes were noted in the epiphysis during this period.

The patient was referred to the Endocrine Clinic in December 1931. Additional interrogation brought out histories of goiter in the mother and in the maternal aunt. Further physical examination revealed a boy short in stature, moderately obese, with poor genital development, left cryptorchidism, retarded dentition, and a palpable thyroid. Roentgenographic studies of the wrist revealed an epiphyseal development equivalent to that in a child of approximately six years. Treatment from this time on consisted of the administration of one grain of thyroid daily. Progressive improvement was noted in the affected epiphysis. Both testicles were found in the scrotum at the end of six months. Weight-bearing was controlled by an abduction-traction brace for fifteen months. At the end of this period there was almost complete reconstruction of the epiphysis, and the brace was removed.

The patient remained under observation for an additional fifteen months. Check-up studies of the hip during this time revealed a comparatively normal epiphysis, with the exception of moderate flattening. There was concomitant improvement in the relation of epiphyseal development to chronological age. Thyroid medication was continued under supervision.

CASE 2. R. P., a white male, aged six years and four months, was admitted in September 1931, with a history of a limp on the left side, asthma, and frequent

* The clinical material presented represents consecutive cases seen in the Adelaide Tichenor Orthopaedic Clinic, Long Beach, California.

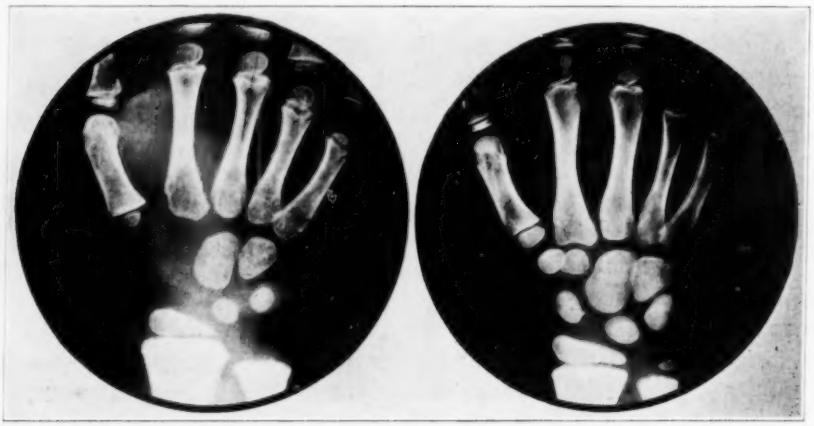

FIG. 3

Case 2. R. P. Patient's wrist (left) compared to approximate normal for age.

colds and sore throats. The onset of the limp had occurred a year previously, and the condition had been present intermittently since that time. The tonsils and adenoids had been removed four months after the onset of the symptoms, with no relief. Physical and roentgenographic findings were consistent with osteochondritis of the left capital

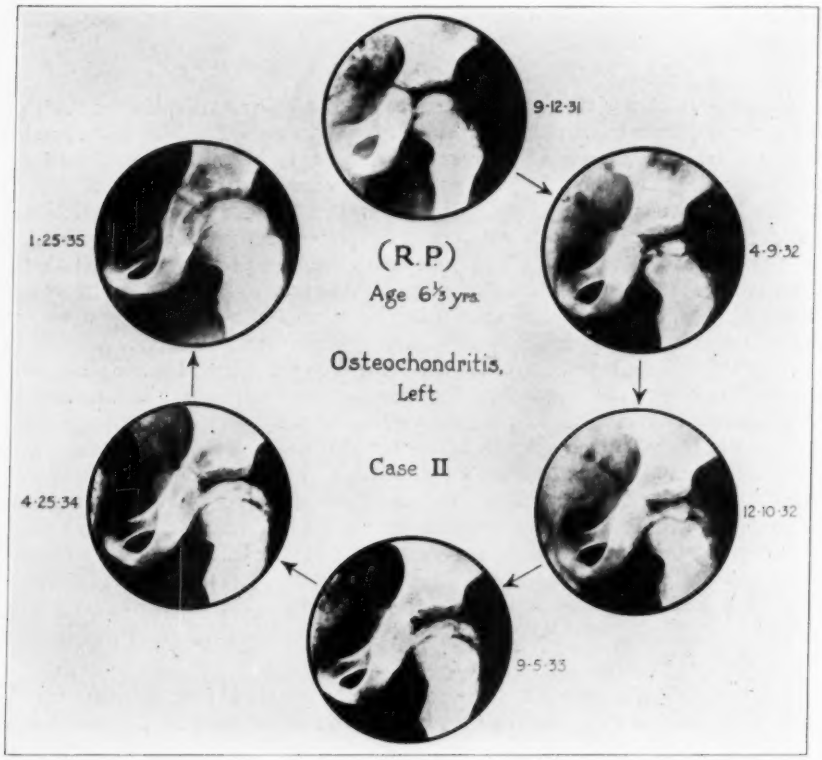

FIG. 4

femoral epiphysis. Treatment for the next nine months consisted of a Bradford abduction-traction brace. Progressive destruction in the epiphysis and in the diaphysis was noted during this period.

The patient was referred to the Endocrine Clinic in May 1932 at which time there was elicited a history of large colloid goiters in the mother, a maternal aunt, and the

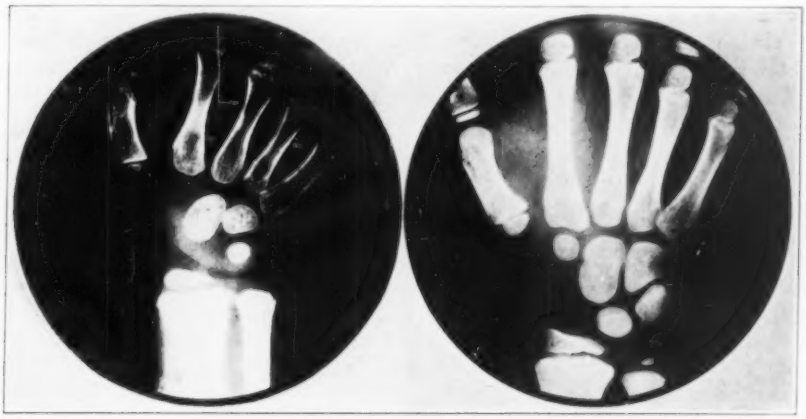

FIG. 5

Case 3. R. B. Patient's wrist (left) compared to approximate normal for age.

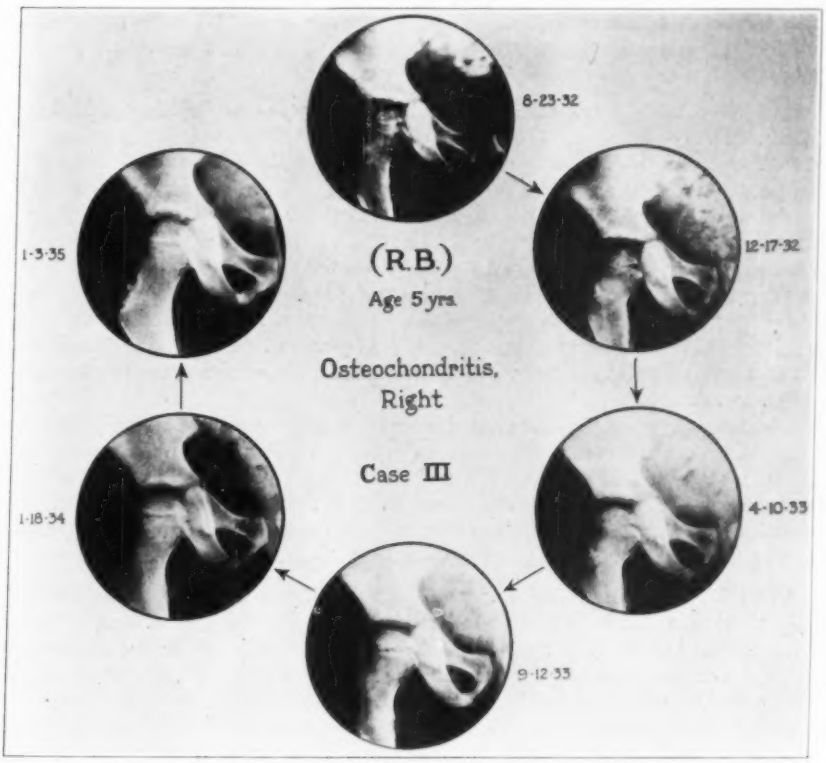

FIG. 6

grandmother and a toxic goiter in another maternal aunt. Further examination revealed left cryptorchidism and an epiphyseal development equivalent to that in a child of approximately four years. Treatment consisted of the administration of from one-half to three-quarters of a grain of thyroid daily. The patient was placed in a cast for three months; a Bradford abduction-traction brace was then applied. Both testicles were found in the scrotum at the end of three months. There was no recurrence of asthma after twelve months.

There was progressive improvement in the epiphysis during the next thirty months, and the brace was removed. There was concomitant improvement in the relation of epiphyseal development to chronological age. Thyroid medication was continued under supervision.

Case 3. R. B., a white male, aged four years and ten months, was examined in the Endocrine Clinic in August 1932. There was a history of a limp on the right side, of three weeks' duration, and enuresis. There had been no known trauma. The family history revealed that the mother, maternal aunt, and two uncles had goiter. In addition to the physical and roentgenographic findings of osteochondritis, large cryptic tonsils and obstructive adenoids were found. Studies of the right wrist revealed an epiphyseal development corresponding to that in a child of three years.

The tonsils and adenoids were removed, and the child was kept under observation. At the end of four months definite retrograde changes were noted in the epiphysis and a Bradford abduction-traction brace was applied. One-half a grain of thyroid daily was prescribed. Enuresis did not recur after the first two months, and progressive improvement was noted in the epiphysis. At the end of twelve months complete reconstruction of the epiphysis was found, and the brace was discontinued.

The patient was kept under observation for an additional twelve months, and check-up studies revealed only normal findings. There was concomitant improvement in the relation of epiphyseal development to chronological age. The administration of thyroid was continued under supervision.

Case 4. D. M., a white male, aged nine years, was examined in the Endocrine Clinic in June 1932. Examination showed a limp on the left side and carious teeth, and the history revealed enuresis and frequent sore throat. The onset of the limp had occurred one month previous to admission. There had been no known trauma. The family history disclosed that the mother had a large colloid goiter. In addition to the physical and roentgenographic findings of osteochondritis, examination showed very dry skin and hair, carious teeth with retarded dentition and a narrow crowded arch, large cryptic tonsils, and an epiphyseal development equivalent to that in a child of from six to seven years. Treatment consisted of the removal of the tonsils and the adenoids, the application of a Bradford abduction-traction brace, and the administration of three-fourths of a grain of thyroid daily. After two months there was no further enuresis nor progress in dental caries.

Check-up studies of the hip revealed progressive improvement in the epiphysis, and, at the end of thirty months, the brace was removed and normal weight-bearing was permitted. The patient remained under observation during an additional five months, and a comparatively normal epiphysis was found at the end of that time. There was concomitant improvement in the relation of epiphyseal development to chronological age. The administration of thyroid was continued under supervision.

Case 5. G. R., a white female, aged six years, was examined in the Endocrine Clinic in February 1933. There was a history of a limp on the right side, abnormal behaviorisms, and enuresis. The limp had appeared following an injury three months previous to examination. The family history revealed that the mother had a palpable colloid goiter. In addition to the physical and roentgenographic findings of osteochondritis, examination disclosed dry skin and hair, malocclusion, and a palpable enlarged thyroid. Studies of the right wrist showed an epiphyseal development equivalent to that in a child of four years and six months. Due to a misunderstanding, the patient was under

observation in another clinic for the next twelve months, where she received no treatment other than occasional observation. At the end of this period she returned to the Endocrine Clinic and roentgenographic examination of the hip revealed almost complete disintegration of the capital femoral epiphysis. There was actual shortening of the right leg amounting to one and one-quarter inches. All of the other disorders were

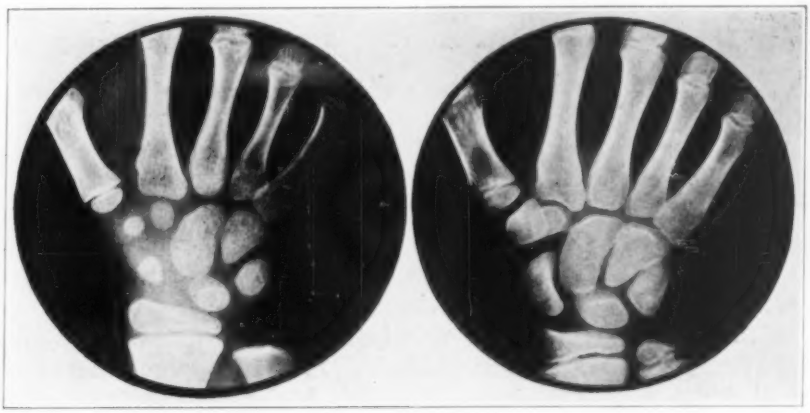

FIG. 7

Case 4. D. M. Patient's wrist (left) compared to approximate normal for age.

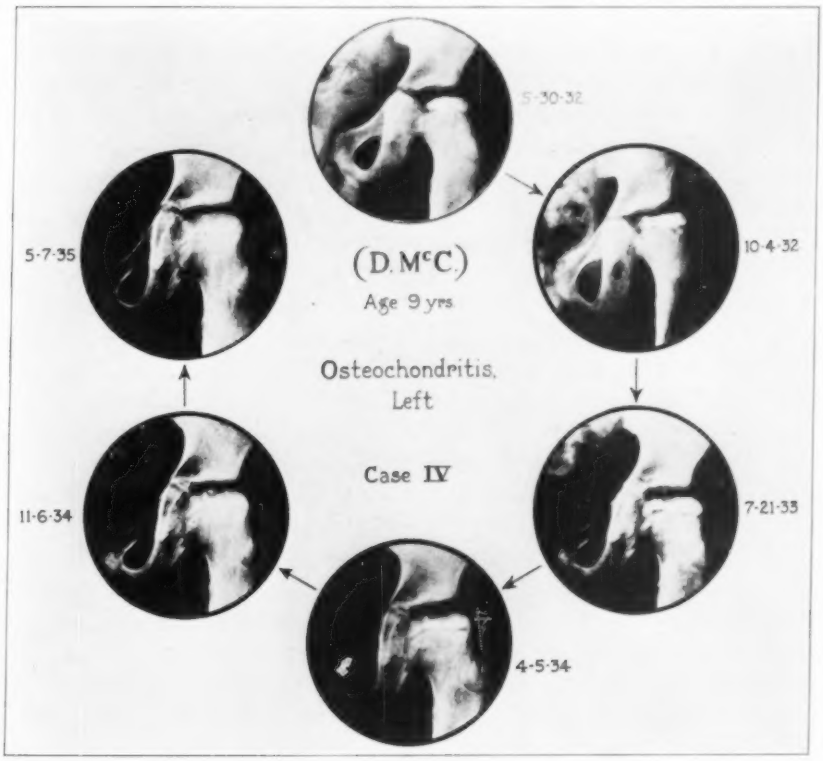

FIG. 8

still present. A Bradford abduction-traction brace was applied and half a grain of thyroid daily was prescribed. Enuresis did not recur after six weeks. Three permanent teeth erupted within two months.

At the end of six months there were no further complaints of abnormal behaviorisms. Progressive improvement was noted in the epiphysis with complete union of all fragments and a smooth articular surface at the end of twenty-two months. The brace was removed. Concomitant improvement was noted in the relation of epiphyseal development to chronological age. The administration of thyroid was continued under supervision.

While numerous observers have cited instances of poor ossification of the affected joint in osteochondritis, apparently no one has considered the degree of development in the other epiphyseal centers,—namely, the general developmental status. As previously stated, Hilgenreiner has described inferior epiphyseal development in the affected joint prior to the onset of osteochondritis. Engelbach and Schaefer, in reporting on endocrine dwarfism treated with an anterior lobe extract, cited the frequent occurrence of what they termed "chondroepiphysitis" in conjunction with dwarfism. Nine cases were reported out of a series of fifteen studied. From a study of the protocols, one is able to find only two of these cases reported in detail. It is significant that in both there was retardation in epiphyseal development of three and four years respectively. Shelton, Cavanaugh, and Evans did not observe any evidence of osteochondritis in a series of children suffering from hypophyseal infantilism, in every one of whom epiphyseal development was normal or only slightly retarded for the age. On the other hand, joint pains have been a rather consistent finding in a large series of children with thyroid deficiency, all of whom presented retarded bone development. The inference, therefore, is that the thyroid factor and not the pituitary factor is paramount in maintaining the normal nutritional metabolism of the osteochondral system, other things being equal.

The age period in which the disease occurs in most instances has made difficult the accurate estimation of basal metabolism. Shelton in 1931 reviewed the work of all previous authors, correlated their findings as regards normal epiphyseal ossification, and presented a chart showing the normal appearance and union of all the epiphyseal centers. He concluded that the rate of epiphyseal development was an index of metabolic speed during childhood and adolescence. Since that time, he and others (Clark and Dorff) have presented clinical material to support the value of epiphyseal studies in estimating the metabolic speed in individuals in whom accurate estimations of oxygen exchange are not possible.

The majority of authors have maintained that osteochondritis occurs in healthy, normal children in whom no conclusive evidence of metabolic deficiency is found. One author, after making such a statement, offers as the etiology an imbalance between the nutritional supply and the physiological demand in the epiphysis. The very processes of supply and demand in nutrition are intimately related to metabolism. The common practice has been to consider an individual without classical stigmata of cretinism or myxoedema as having a normal metabolic speed. The whole

question hinges on the proneness of physicians to look for a classical picture which, after all, is a terminal state of a long-standing metabolic imbalance and as slow in development as is the process of growth.

Of the five cases under discussion, enuresis was present in three,

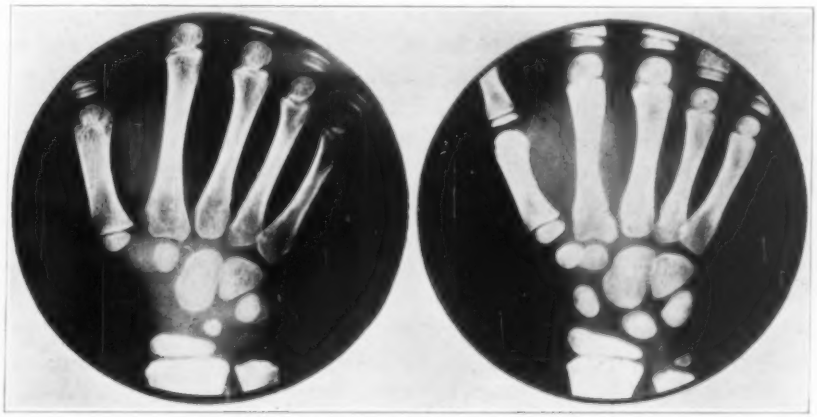

FIG. 9

Case 5. G. R. Patient's wrist (left) compared to approximate normal for age.

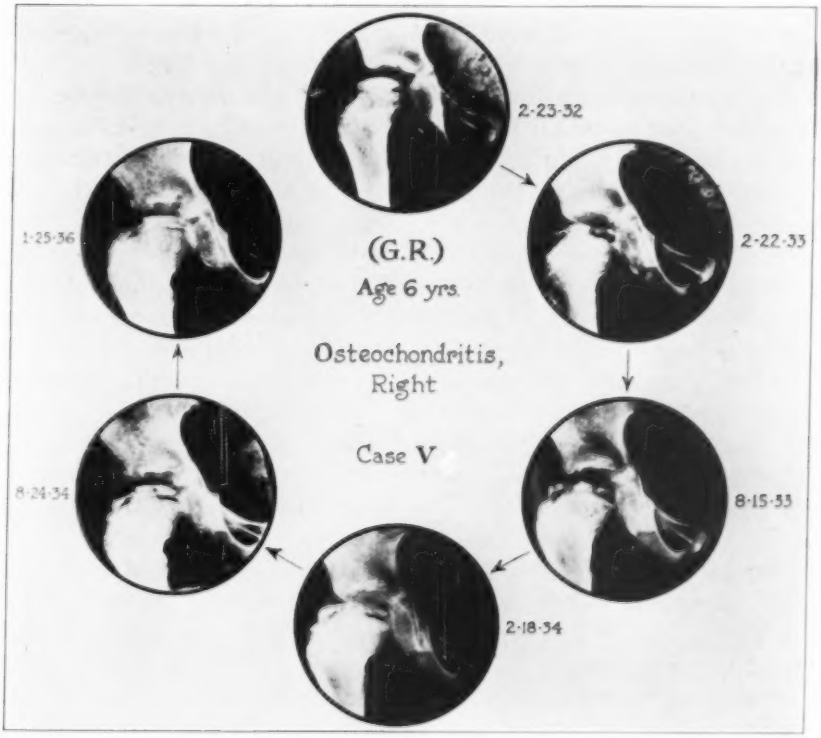

FIG. 10

retarded dentition in three, cryptorchidism in two, hypogenitalism in one, and asthma in one. None had an appearance of cretinism or of juvenile myxoedema, yet all were found to have from eighteen to thirty-six months' retardation in epiphyseal development. Frank goiter was present in three mothers and a palpable enlarged thyroid in two. A history of goiter on the maternal side was given by three patients.

In a recent survey of 560 school children between the ages of five and twelve years, Shelton reported only 12.5 per cent. as having a retardation in epiphyseal development of more than two years. Of the five cases of osteochondritis reported in this paper, 100 per cent. had such retardation. It is accepted that osteochondritis of the capital femoral epiphysis is much more common in males than in females. In this regard it is interesting that epiphyseal ossification is normally more delayed in males. Clark states that at four years females are nine months more advanced than males and at twelve years they are from one to two years more advanced. This sex difference in rate of epiphyseal ossification may partially explain the sex difference in the incidence of osteochondritis.

No attempt has been made to present a statistical study of the duration of the disease in the cases presented. It is well established that ordinarily the course extends over a period of from two to six years. The number of cases presented herewith is limited and there was so much variation in the stage of development of the disease when measures to increase metabolic speed were instituted that statistical studies would probably have been more confusing than informative. Conclusions as to the possible shortening of the morbid period from such a regimen would, therefore, be unjustified. It is interesting to note, however, the consistency with which beginning restoration of normal epiphyseal structure occurred after thyroid therapy was instituted. This is particularly evident in Cases 1 and 5.

In addition to the series reported, the authors have under observation four cases of osteochondritis of the tibial tubercle with lowered basal metabolic rates and retarded epiphyseal development in three; two cases of osteochondritis of the os calcis and one of the dorsal spine, all with lowered basal metabolic rates, retarded bone development, and other signs of hypothyroidism. These we plan to report later.

A careful analysis of the literature fails to reveal any reference to roentgenographic studies of (non-affected) epiphyseal centers in order to check the rate or the degree of development in osteochondritis. Heretofore, an individual suffering from this disturbance was commonly considered normal if otherwise free from the gross or terminal evidence of metabolic disease. The five cases presented tend to demonstrate that this conclusion is not justified until the general metabolic status is more thoroughly investigated.

Snodgrass, in 1932, reviewed the material prepared by Lippmann from one case and stated that he was greatly impressed with the similarity of the changes to those observed in normal bone repair. In a compre-

hensive review of the literature, he cites considerable evidence to support this view. If, as he suggests, osteochondritis represents changes which ensue during the stages of aseptic necrosis and normal bone repair, it is not impossible that the abnormal process is commonly the result of lowered metabolism with poor ossification in the epiphyseal centers, one or more of which fail under the stress of weight-bearing or other trauma. In this regard, it is realized that insufficient material has been studied to allow positive conclusions. The authors present the material with the hope that other investigators will study the entire osseous structure and the individual metabolic status in order to refute or to verify these findings. Eventually, sufficient material may be collected to allow a true measurement of the etiological importance of altered metabolism, particularly as regards the thyroid status, in osteochondritis.

SUMMARY

In the five unselected cases of osteochondritis of the capital femoral epiphysis presented, a high incidence of metabolic disorder—namely, colloid goiter—was discovered in the patients' families. Definite evidence of metabolic disorder, as indicated by retarded bone development and numerous other stigmata, was discovered in the patients. In three cases the disease had been present and active for from twelve to fifteen months before measures designed to raise the metabolic level were begun. The metabolic factor in the remaining two was recognized soon after the onset of symptoms. There was an early and consistent restoration of normal epiphyseal structure in all cases after thyroid therapy was instituted. The importance of more thorough investigation of the entire osseous structure, particularly as regards the rate and degree of epiphyseal ossification in osteochondritis, is emphasized.

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FRACTURES OCCURRING AFTER OPERATION FOR OSTEOMYELITIS OF THE FEMUR, WITH ULTIMATE UNION

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The following cases are reported because a survey of the literature fails to produce detailed records of similar cases in which the infected long bone, partially removed in its circumference, unites firmly.

CASE 1. G. W., a female, aged twelve, of Polish extraction, entered the Orthopaedic Service on July 7, 1935. She gave a history of having had pain in the right hip and thigh for a period of one month. There had been true chill and temperature of 104 a few days prior to admission.

On examination the child was found to be pale, thin, and acutely ill. The temperature was 102.4; the pulse, 120; and respirations, 24. Examination of the throat was essentially negative. The heart and lungs were normal except for a mild tachycardia. The abdomen was soft with no areas of tenderness nor masses. The reflexes were sluggish. The right thigh was swollen, hot, and painful to pressure. There was some tenderness in Scarpa's triangle. The hip joint was slightly limited in flexion and abduction.

The laboratory findings were as follows:

Red blood cells—3,700,000
Hemoglobin—75 per cent.
White blood cells—14,800
Polymorphonuclear neutrophiles—82 per cent.
Small lymphocytes—10 per cent.
Large lymphocytes—6 per cent.
Transitional cells—2 per cent.
Kahn test, negative; urine, negative except for a few white cells.

A diagnosis of osteomyelitis of the right femur with possible involvement of the hip joint was made. The child was operated upon on the day of entrance. The femur was guttered in the accepted manner and packed wide open with vaselin gauze. The periosteum was found to be thickened and oedematous, and it stripped easily from the bone with little or no bleeding. A culture of the material secured at operation showed pure staphylococcus aureus.

On the thirty-ninth day the patient was transferred to the Convalescent Home. Five days later the child fell from a wheel chair and fractured the leg which had been operated upon. The roentgenogram (Fig. 1) disclosed a fracture at the junction of the upper and middle thirds of the femur.

The patient was returned to the hospital for operation. The bone ends were exposed by retraction of the original wound edges, and overlapped for a distance of one inch. These ends were drilled and held by two pieces of rustless steel wire. The fracture site was covered by suturing the soft parts with chromic catgut. Both ends of the incision were packed open with iodoform gauze. A Kirschner wire was put through the tibial crest and ten pounds of traction was applied.

Seventeen days later roentgenograms demonstrated a considerable amount of bony callus. (See Figure 2.) Three weeks later roentgenograms again demonstrated an increase in callus and a slight sequestration of the ends of the bones. (See Figure 3.)

On the forty-fourth day the child was again transferred to the Convalescent Home with the traction intact. Examination at this time revealed firm bony union and one inch of shortening. (See Figure 4.) The traction and the Kirschner wire were removed

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FIG. 1

Case 1. Fracture at the junction of the upper and middle thirds of the femur.

FIG. 2

Case 1. Roentgenogram, seventeen days after operation, showing a considerable amount of bony callus.

FIG. 3

Case 1. Roentgenogram taken three weeks later than Fig. 2. Note the increase in callus and the slight sequestration of the ends of the bones.

at the end of seven days. The child was allowed on crutches three weeks later, and was given a walking caliper brace on December 10, 1935 (fourteen weeks following the fracture).

CASE 2. F. V., a male, aged sixteen, of Polish extraction, was admitted to the Orthopaedic Service on August 23, 1935. He gave a history of having had pain in the right thigh coincident with generalized aching and chills six weeks previously. These complaints had become worse over a period of three weeks, at the end of which time the femur had been opened through an anterior low-thigh incision. Following surgery there had been no relief from pain and the temperature had continued.

On examination the patient was found to be pale and undernourished. The temperature was 99.5; the pulse, 120; and respirations, 25. Examination of the throat was essentially negative; the tonsils were absent. The heart and lungs were normal except for a tachycardia. Examination of the abdomen was negative. The reflexes were not unusual. There was a ten-centimeter wound on the anterior aspect of the lower third of the right thigh. A gauze pack was present. The entire thigh was hot. There was no limitation in hip motion.

The laboratory findings were as follows:

Red blood cells—3,810,000
Hemoglobin—70 per cent.
White blood cells—10,300

FIG. 4-A

FIG. 4-B

Case 1. Roentgenograms taken forty-four days after operation. Firm bony union has occurred and there is one inch of shortening.

FIG. 5

Case 2. Fracture of the lower end of the femur. The lower fragment is markedly angulated, rotated, and overriding.

FIG. 6

Case 2. Roentgenogram, taken eighteen days after operation, showing a considerable amount of bony callus and the fragments in good position.

FIG. 7

Case 2. Roentgenogram taken five weeks after Fig. 6. Note the abundant callus.

Polymorphonuclear neutrophiles—73 per cent.
Small lymphocytes—12 per cent.
Large lymphocytes—7 per cent.
Transitional cells—5 per cent.
Eosinophiles—2 per cent.
Basophiles—1 per cent.
Kahn test, negative; urine, negative except for a trace of albumin.

The diagnosis was evident, and the boy was operated upon on the fourth day. The usual gutter was made and packed wide open. A culture of the material obtained was reported as pure staphylococcus aureus.

The postoperative recovery was good and on the twelfth day the patient was transferred to the Convalescent Home. The wound healed well and the general condition improved over a period of three months. At this time the boy complained of pain in the leg and showed a moderate elevation of temperature. The pulse rose to 130. The patient was transferred to the hospital and the femur was again exposed. A sinus was found which led through the entire cortex to the medial side of the shaft and which contained a few small sequestra. This was curetted and packed.

On the tenth postoperative day an abnormal contour of the thigh was noted. There was an obvious bowing of the leg laterally. Roentgenograms revealed a fracture of the lower end of the femur; the lower fragment was markedly angulated, rotated, and overriding (Fig. 5). At no time had the patient complained of any unusual pain aside from that which was expected from the surgery.

The boy was returned to the hospital for operation. The bone ends were exposed and the fragments were curetted until bleeding was obtained. Grossly there appeared to be no periosteum about the fracture site. One piece of rustless steel wire was used to hold the fragments in firm apposition. The soft parts were allowed to fall back into place. The leg was placed on a modified Böhler frame. A Kirschner wire was put through the tibial crest and ten pounds of traction was applied.

Eighteen days later roentgenograms demonstrated a considerable amount of bony callus with the fragments in good position. (See Figure 6.) The wound drained freely. The temperature peaks reached 102. Five weeks later clinical examination gave the impression of union. Roentgenograms at this time revealed abundant callus. (See Figure 7.) The frame and traction were removed, and on March 23, 1936 (thirteen weeks following the fracture) the patient was given a walking caliper brace.

COMMENT

It is to be noted that Case 1 was purely traumatic and that Case 2 was pathological in character. In the latter case the bone appeared unhealthy and at the time of wiring little hope was held for solid union.

Close examination of the roentgenograms demonstrates very little, if any, bone production along the lateral aspect of the shaft in the guttered area. On the contrary, callus is clearly seen appearing on the medial and posterior aspects of the femora. * These areas were not disturbed surgically except for drilling. These observations would indicate that for the most part the repair comes from the periosteum and not from the cortical bone.

* Since the inception of this paper a third case has come under our observation which shows the appearance of callus as described above,—abundant production medially and posteriorly on the shaft of the femur.

THE OCCURRENCE OF ABSCESSES FROM TUBERCULOUS HIPS THAT ARE FIRMLY ANKYLOSED *

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Many methods have been developed and described as the proper and best way to produce ankylosis in tuberculous hip disease. However, in the author's opinion there is no one method which is applicable in every case. The operation must be varied according to the conditions found when the hip joint and surrounding structures have been exposed at the time of operation. This is especially true when a previous operative fusion has failed.

The pedunculated graft, including the outer cortex of the ilium and hinged at the capsule if possible, is a good method, but in children under ten years of age the graft becomes cartilaginous where it is surrounded by the cartilage of the trochanteric epiphysis, and it is two or three years before this attachment becomes bony and is solid. (See Figures 1-A and 1-B.)

Moreover, it is the writer's belief that a graft extending from the ilium to the trochanter, as produced by this method, or by the methods of Hibbs, Albee, or Bristow, is not enough. The head still moves in the socket even when the graft has attached itself to the ilium and to the trochanter, and these grafts not infrequently break. (See Figure 2.)

From his experience at the Lakeville State Sanatorium the author has been led to believe that the Hibbs, Wilson, Bristow, or Albee operations alone are not enough to lock the hip, and that it is advisable if possible to do at the same time Ghormley's operation (as in Case 7850) or a similar procedure to steady the head in the socket.

In general the writer considers that operations which require disarticulation of the head are not good. If the head and socket are stripped of cartilage, the head is loosened in the socket and is less likely to become attached.

Table I lists forty-eight cases of tuberculous hips treated at the Lakeville State Sanatorium. In all of these cases the hips became firmly ankylosed. In eighteen cases the ankylosis was spontaneous. In nine, or 50 per cent., of these eighteen cases sinuses persisted after bony ankylosis had taken place, and in one case (8049) an abscess developed fifteen years after bony ankylosis was complete.

In thirty of the forty-eight cases operation for ankylosis was performed, but not all of these operations were done at the Lakeville State Sanatorium, for some of these patients were sent to the Sanatorium for convalescence after the operation. In six of these thirty cases (20 per cent.) abscesses developed after ankylosis was clinically firm.

In three of these cases (6672, 7145, and 7279) the bone-flap operation

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 20, 1936.

TABLE I

RÉSUMÉ OF FORTY-EIGHT CASES OF ANKYLOSIS OF TUBERCULOUS HIPS SEEN AT LAKEVILLE STATE SANATORIUM DURING THE THREE-YEAR PERIOD TO MARCH 13, 1936

Case No.	Initials	Operation for Ankylosis	Sinuses	Final Result
7117	J.F.	No	Multiple	Sinuses continued.
7250	S.M.	No (Osteotomy to correct position)	Yes	Sinuses closed. Good result.
7323	C.T.	No	No	Firm ankylosis.
7430	P.G.	Yes	Yes	Sinuses closed.
7453	D.Z.	No	Multiple	Sinuses continued.
7470	H.B.	Yes	No	Firm ankylosis.
7460	M.S.	No	Yes	Sinuses closed.
6561	J.Y.	No	Yes	Sinuses closed.
7602	A.K.	No	Yes	Firm ankylosis. Sinuses open. Died.
7628	L.G.	No	No	Firm ankylosis.
7664	P.G.	No	No	Firm ankylosis.
7619	A.H.	Yes	Yes	Firm ankylosis. Profuse discharge. Died.
7895	A.C.	No	Yes	Firm ankylosis. Sinuses continued.
7042	C.S.	Yes	No	Firm ankylosis.
7430	P.G.	Yes	Yes	Firm ankylosis. Sinuses closed.
6544	A.G.	Yes	No	Firm ankylosis.
7059	A.B.	Yes	No	Firm ankylosis.
7071	A.B.	Yes	No	Firm ankylosis.
7074	T.K.	Yes	Yes	Firm ankylosis. Slight drainage.
7114	E.O.	Yes	No	Firm ankylosis.
7119	F.M.	Yes	No	Firm ankylosis.
7444	J.D.	No	Yes	Firm ankylosis. Sinuses continued.
7558	A.L.	Yes	Yes	Firm ankylosis. Sinuses closed.
7251	N.J.	No (Osteotomy)	No	Firm ankylosis.
7247	N.J.	Yes	No	Firm ankylosis.
7406	I.S.	No	No	Firm ankylosis.
7153	O.	No	No	Ankylosed in good position.
6997	T.D.	Yes	Yes	Firm ankylosis. Sinuses closed.
7174	J.W.	Yes	No	Firm ankylosis.
7279	V.R.	Yes	Yes	Firm ankylosis. Sinuses continued.
7122	W.R.	Yes	Yes	Firm ankylosis. Sinuses healed.
7694	S.K.	Yes	Yes	Firm ankylosis. Sinuses continued.
7555	E.P.	Yes	No	Firm ankylosis.
7360	A.B.	Yes	No	Firm ankylosis.
7218	M.O.	Yes	No	Firm ankylosis.
7835	L.G.	Yes	No	Firm ankylosis.
7707	A.F.	No	Yes	Firm ankylosis. Sinuses continued.
7488	W.C.	No	Yes	Firm ankylosis. Sinuses continued.
7177	W.W.	Yes (Graft not holding)	No	Firm ankylosis.
7850	L.G.	Yes (Double operation)	No	Firm ankylosis.
8049	A.A.	No	Yes	Firm ankylosis. Sinuses continued.
6654	J.W.	Yes	No	Firm ankylosis.
4635	W.D.	No	Yes	Firm ankylosis. Sinuses continued.
7238	E.H.	Yes	No	Firm ankylosis.
6672	H.C.	Yes	Yes	Firm ankylosis. Sinuses continued.
6831	A.S.	Yes	No	Firm ankylosis.
7145	B.S.	Yes	Yes	Firm ankylosis. Sinuses continued.
6940	F.M.	Yes	Yes	Firm ankylosis. Sinuses closed.

FIG. 1-A

FIG. 1-B

T. D. (6997), a boy, eight years of age.

Fig. 1-A: Roentgenogram showing cartilaginous tip of graft after it had been placed into the trochanteric cartilage.

Fig. 1-B: Roentgenogram three years later showing that the cartilage is becoming bony.

FIG. 2

E. O. (7114). Roentgenogram showing fracture of the graft. Bristow's operation was performed in this case.

FIG. 3

B. S. (7145), February 13, 1936. A bone-flap operation had been performed three years previously. The roentgenogram shows that Beck's paste, inserted through a sinus in the thigh, led to the bottom of a socket inside the pelvis.

described by Wilson was the only procedure used. In one case, although the hip clinically appeared locked, the fact that the sinuses led to the deep socket inside the pelvis (Fig. 3) seemed to indicate that the head must have moved slightly in the socket.

CONCLUSIONS

In the treatment of tuberculous hips the following points should be emphasized:

1. The operation to lock the hip should fix the head as well as the trochanter in order to prevent development of abscesses.

2. Abscesses may develop and sinuses may continue to drain when there is clinically solid bony ankylosis.

3. A solid bony ankylosis is, nevertheless, the best result that can be obtained and is the least likely to cause subsequent abscess formation.

A NEW USE FOR THE KNICKERBOCKER TONGS

Correction of Diastasis after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type)

BY EDWARD RAYMOND EASTON, M.D., F.A.C.S., NEW YORK, N. Y.

Ashhurst, whose monumental work on the classification of ankle fractures will probably stand the test of time, divided them according to mechanism into five groups, with subclassifications: (1) fractures by external rotation; (2) fractures by abduction (fibular flexion); (3) fractures by adduction (tibial flexion); (4) fractures by compression in the long axis; and (5) fractures by external violence (supramalleolar type).

The fracture of the posterior lip of the tibia, resulting in backward displacement of the foot, was practically always, in Ashhurst's opinion, a complication of the first type (external rotation). It was first described by Cooper in 1822, but in 1915 Cotton mentioned it as a new type of fracture. Cotton believes that all major fractures about the ankle present some features of a dislocation as well, in that there is at times a considerable displacement of the foot. He divides them into four different types from the standpoint of treatment: the Pott's fracture, the reversed Pott's fracture, the so called "Cotton's fracture", and the compression fracture.

The writer believes that all four types of fracture can occur without much widening of the mortise and without marked laceration of the inferior tibiofibular ligaments. While in some cases the ankle mortise is satisfactorily restored, in others diastasis persists after the fracture has been successfully reduced. This condition is readily recognized by measurement with carpenter's calipers of the distance between the tips of the two malleoli.

The widening of the mortise has been corrected by means of screws, bolts, and other mechanical devices which will approximate the tibial and fibular fragments. This, however, necessitates an open operation and exposes the patient to the danger of infection. Cotton mentions the use of tongs in compression fractures, but, so far as the writer can discover, this method has not been employed before for closing the ankle mortise *per se*.

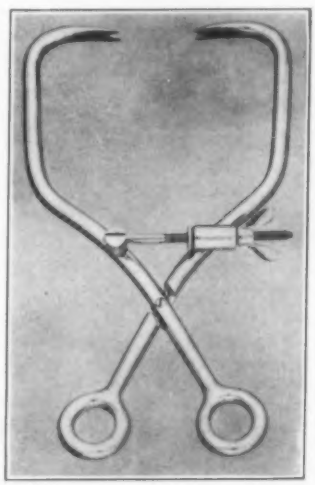

Fig. 1
The Knickerbocker tongs.

The first case herewith reported is an unusual type of fracture of the upper third of the fibula. It was described in 1840 by Maisonneuve, who had never seen the condition clinically but who was able to produce it experimentally on cadavera. It is a

FIG. 2

Lateral view, showing torsion fracture of the upper third of the fibula and fracture of the posterior lip of the tibia, after reduction of posterior displacement.

torsion fracture, such as is always associated with rupture of the internal lateral and inferior tibiofibular ligaments. As in the present case, it is usually complicated by a fracture of the posterior margin of the tibia and by a posterior displacement of the foot as in Cotton's fracture. Since it was described by Maisonneuve, the torsion fracture of the fibula has been recognized clinically on account of its unusual features. Ashhurst, who had a case of this type in his collection of 300 ankle fractures, quotes Destot as having treated four Maisonneuve fractures with an associated fracture of the posterior lip in a group of 1,700 cases.

The mechanism is, without doubt, that of external rotation, which results in the sudden giving way of the internal lateral and inferior tibiofibular ligaments, allowing a widening of the ankle mortise. This is accompanied immediately by a compression fracture of the posterior lip of the tibia, caused by an upward and backward thrust of the astragalus and a backward dislocation of the foot. This is followed by a torsion fracture of the upper third of the fibula.

In the following case this mechanism was undoubtedly the cause of the fracture.

T. Q., aged thirty-two, a white male, weighing 200 pounds, with no occupation, fell on an icy sidewalk and was admitted to the Knickerbocker Hospital January 21, 1936. Although the patient was inebriated at the time and could not state clearly how the accident had happened, it was apparent that the weight of his body had produced the series of lesions.

Physical examination elicited clicking on movement from side to side of the right foot and ankle. Prominence of the tibia anteriorly at the ankle and dislocation backward on the astragalus were noted. Intermalleolar measurement showed widening of two centimeters of the mortise of the right ankle as compared with that of the left ankle. Shortening of the leg, amounting to one centimeter, was present.

Roentgenographic examination disclosed a spiral fracture of the middle third of the shaft of the fibula, with the fragments in fairly good position. There was also a fracture through the distal end of the right tibia near its posterior aspect with spreading of the ankle mortise.

The luxation of the foot and the fracture of the posterior margin of the tibia were easily reduced, but the diastasis of two centimeters between the malleoli and the shortening of the leg by one centimeter still remained. Posterior molded and hairpin

plaster-of-Paris splints were applied, with the foot in dorsiflexion and inversion in midposition.

On January 22, the hairpin splint was removed and the malleoli were exposed, the posterior molded splint being left in place. Under ether anaesthesia, the Knickerbocker tongs were applied as follows: Half-inch incisions were made down to the bone at points one-half an inch above the internal malleolus and one inch above the external malleolus. The prongs of the tongs were adjusted to the ridges of both bones through the small wounds and approximated by a thumb-screw. Dry sterile dressing was then applied. The posterior molded splint was so placed that the tongs encompassed it at the sole of the foot. Lateral plaster splints extended down to one inch above the malleoli and were bandaged in place. Two plaster bandages incorporated the tongs, splint, and foot in dorsiflexion and prevented joggling. Three pounds of traction was applied.

On the same day, roentgenographic examination showed reduction of the diastasis.

On February 20 the tongs were removed, and there was no evidence of infection in the wounds. Sterile vaselin gauze was applied, and two plaster bandages were placed circularly around the foot and the ankle. On March 7 the plaster splints were cut off just below the knee to allow flexion.

The entire cast was removed on March 17, and the wounds caused by the tongs were found to be completely healed. There was only moderate swelling around the ankle. Roentgenographic examination showed the bones approximated, exactly as they were on January 22 after application of the tongs. Outside measurements of both ankles were the same. There was no shortening of the leg. Movements of the right ankle and the subastragalar joints were comparatively free considering the eight weeks' confinement in splints. The foot showed no backward displacement relative to the articular surface of the tibia; the fracture was healed with moderate callus; and the weight-bearing line appeared to be normal. The leg was firmly strapped with an adhesive stirrup, and the patient was instructed not to bear weight for at least two more weeks.

On March 30, 1936, the patient walked without a limp. The integrity of the inferior tibiofibular joint was restored. Movements of the ankle and the foot were functionally perfect.

The traction tongs used in this case were evolved by the writer early in 1934, and have since been giving excellent results in skeletal traction. It was at the suggestion of Dr. Ellsworth Eliot, Jr., Director of Surgery at the Knickerbocker Hospital, that they were tried in this case for the first time to correct a diastasis of the malleoli in a fracture of the ankle. Due to the corrugation of the inner surface of the prongs and their termination in two points instead of one, a large gripping surface is afforded which holds firmly without puncture of the bone cortex. A lock screw prevents slipping, and there is no danger of piercing the bone by added traction. (See Figure 1.)

A second case was treated at Knickerbocker Hospital by an associate, Dr. William A. Fraser.

J. M., aged forty-five, a carpenter, was admitted on July 28, 1936, with a severe compound fracture and dislocation of the right ankle of the supramalleolar type, with marked diastasis; also multiple fractures of the pelvis and dislocation of the right shoulder. The patient was in shock. Dr. Fraser first inserted a Steinmann pin through the os calcis, but the dislocation recurred. At Dr. Eliot's suggestion he applied the Knickerbocker tongs. Immediate restoration of the fragments to their proper relation, with normal contour of the ankle joint, was visible. Despite violent delirium from pneumonia and alcoholism, this position was maintained until the patient's death thirty-six hours later.

There appears to be very little mention in the literature of repair of

FIG. 4

Anteroposterior view, showing closure of the ankle mortise after application of the Knickerbocker tongs.

FIG. 3

Anteroposterior view, showing diastasis of the tibiofibular articulation after application of plaster splints.

the ankle mortise and end results in diastases of this kind. Cotton suggests that the separation between the malleoli is easily overlooked, due to the overlapping of bones in the anteroposterior roentgenogram. Diastasis may, therefore, be present when there is no open gap apparent between the tibia and the fibula. To quote from Cotton:

"Operations most ingenious have been devised to remedy this condition. In fresh cases, however, the deformity can be reduced by downward traction on the foot combined with compression about the malleoli; the foot should be held in varus posture. The unreduced lesion is disabling. This condition must always be considered in diagnosis and treatment of ankle fractures."

The statement that the deformity (widening of the mortise) can be reduced by downward traction of the foot suggests another form of treatment,—namely, the Steinmann nail through the os calcis, with the traction or the distraction method of Bosworth.

The treatment by the tongs as advocated here is indicated only in those cases in which widening of the mortise persists after reduction has been accomplished. In posterior marginal fracture with involvement of the internal malleolus, the application of tongs may be difficult, though possible. In no case should tongs be used unless they can be so placed as not to exert pressure on the line of fracture with consequent separation of the fragments. It must be emphasized that the object of this method in the treatment of ankle fractures is only to correct the diastasis of the inferior tibiofibular joint, and not to reduce the fracture.

In general, it is the writer's opinion that the method of treatment adopted in this case will give results as good as, or more satisfactory than, other methods suggested. It is recommended that its actual value should be determined by its use in a considerable number of cases. At least it may be said that the possibility of infection is much less than when the diastasis is corrected by the use of screws, bolts, nails, or other mechanical appliances.

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A NEW OPERATIVE PROCEDURE FOR INSTABILITY OF THE KNEE *

BY H. PAGE MAUCK, M.D., RICHMOND, VIRGINIA

The problem of the unstable traumatic knee covers a much larger field than that group of cases with such extreme lateral and anteroposterior play as to cause almost complete disability. A much larger group is constituted by those cases in which the instability is of such a degree as to be the important factor in causing recurrent sprains and in producing such changes in the joint as have been characterized as traumatic arthritis. In many of these cases the cartilage has been removed only to make the abnormal play more obvious. It is probable that many of these cases could be relieved by such an operative procedure as is to be described. However, the author's experience has been limited to cases in the first group with the very extreme and disabling instability.

In a paper read before the American Orthopaedic Association in 1925, the author discussed the pathology and treatment of acute injuries of the internal lateral ligament. In this study, it was demonstrated by experiments on fresh cadavera that the application of force which abducts and externally rotates the tibia on the femur with the knee slightly flexed (the position in which most injuries to the medial collateral ligament take place) practically always tears the ligament away from the head of the tibia, and the anterior fibers of the ligament suffer the greatest damage. From further study of the most severely injured joints—cases of dislocation and of fracture of the head of the tibia—the writer is convinced that the injury to the internal lateral ligament, which *accompanies* the damage to other structures, takes place usually at the same site. Thus, the attachment of the internal meniscus is torn from the head of the tibia and, with the joint distended, the torn internal lateral ligament with the cartilage attached is widely separated from the head of the tibia. If this condition is allowed to persist, the interval between the head of the tibia and the torn lateral ligament is filled with blood clot and subsequently by fibrous tissue, resulting in a lengthened internal lateral ligament and hypermotile cartilage. In order to prevent such results the author advocated: (1) aspiration at the end of forty-eight hours, which is the earliest time that can be depended upon to prevent recurrence of the effusion; (2) application of a hinged cast to prevent abduction and rotation; (3) early use with exercises to develop the musculature. The experiments seemed to prove the rationale of such a procedure, and clinical experience has substantiated the correctness of these deductions. Of a series of sixty-eight severely injured knees, treated in the manner described and followed over a seven-year period,

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 19, 1936.

only two required removal of the cartilage and none required any operative procedure for instability.

From such studies and the findings at operation, it seemed to the author that the instability was due to the *laxity* of the medial ligament rather than to *weakness* of the structure, and if weakness existed it was in that part of the ligament adjacent to the tibial head,—that portion which has healed by fibrous tissue. Weakened quadriceps and vasti muscles always accompany such a condition. The writer, therefore, concluded that, if the integrity of these structures could be restored, the instability would be relieved and good function would be obtained, regardless of whether or not the crucial ligaments were intact and functioning. The experiences of many other writers seem to prove that such a deduction is correct.

Practically all operative procedures that have been recommended for this disabling condition have been aimed at strengthening or reenforcing a weakened lateral ligament, and little attention has been paid to the actual and efficient shortening of the structure. Some of the operations suggested have been plication, with or without fascial suture, and reenforcement of the sartorius, gracilis, and semitendinosus muscles with silk, fascia, and tendons. All of the advocates of such procedures recognize the importance of the restoration of the strength of the muscles of the thigh, but apparently little attention has been paid to how this could be accomplished.

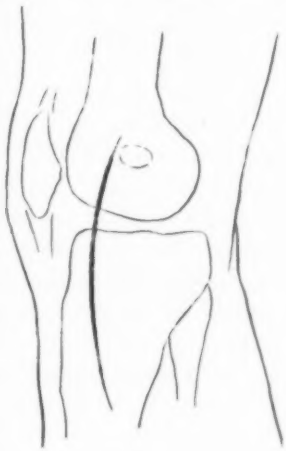

FIG. 1
Showing curved incision.

The writer has felt that the problem consisted of finding some operative procedure which would accurately and effectively shorten the relaxed ligament and eliminate that weakened part which is made up of scar tissue. In addition to this, some provision should be made to allow early use for the restoration of the weakened and atrophied muscles.

With these thoughts in mind, the author has devised the following technique which has proved to be satisfactory. If necessary, it can be modified by the addition of any of the methods of reenforcement.

OPERATIVE TECHNIQUE

A slightly anterior curved incision is made over the inner side of the joint, extending from the adductor tubercle of the femur to four inches below the articular surface of the tibia (Fig. 1). This is carried through the skin and fascia which are dissected backward and forward, so that the structures can be retracted and the whole of the inner side of the capsule and of the head of the tibia can be exposed. With a broad chisel, the inner side of the head of the tibia, with the lateral ligament attached,

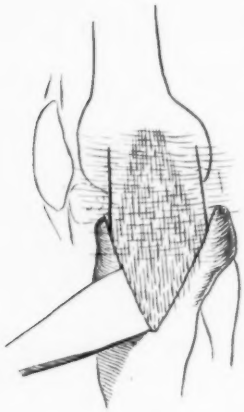

FIG. 2

Removal of the bone flap from the inner head of the tibia. Incisions extend upward through the capsule.

is removed and reflected upward. This section of bone is from one and one-half to two inches in length and about half an inch thick at the articular surface, and is triangular in shape (Fig. 2). At the joint surface the capsule is split upward for about an inch at both the anterior and posterior margins of the bone flap. As the flap of the capsule with the bone attached is reflected (if it has not been removed), the internal semilunar cartilage will be seen to be attached to the flap but still bound to the head of the tibia at its anterior and posterior ends (Fig. 3). After full reflection the cartilage is removed with scissors from its attachment to the inner aspect of the flap. When the flap is fully turned up, the whole inner aspect of the joint is exposed and, by flexion and abduction of the leg on the thigh, the fat pads, the crucial ligaments, and the interior of the joint in both the anterior and posterior aspects can be examined (Fig. 4).

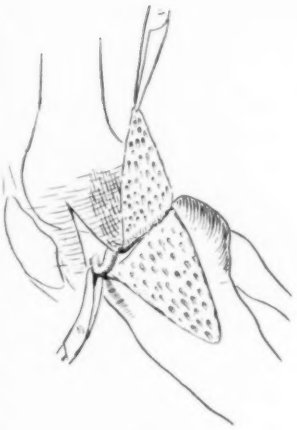

FIG. 3

Removal of the attached internal semilunar cartilage as the flap is reflected upward.

To shorten the ligament, the ligament and bone flap are drawn strongly downward and the point to which the articular surface of the bone flap can be brought is marked by a chisel cut. This distance has averaged three-quarters of an inch in the writer's cases with a maximum of one and one-quarter inches. One-quarter of an inch below this point, a notch is chiseled in the side of the tibia according to the depth and width of the bone flap. Additional bone is then removed from below to accommodate the flap. At the lower end a small shelf of overhanging bone is left under which the lower end of the transplanted bone flap can be slipped and locked. The upper margin of the area of the tibial end is beveled upward and inward, and the upper articular surface of the bone flap is denuded of the cartilage by beveling downward and out-

FIG. 4

Exposure of the interior of the joint, obtained by abducting the tibia on the femur. Note the outline of the new bed for the transplanted bone flap.

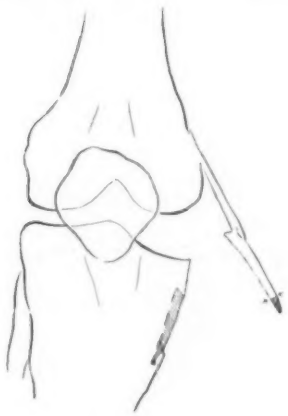

FIG. 5

Showing the beveled upper surface and the overhanging shelf of the new bed to allow mortising of the transplanted flap.

ward (Fig. 5). The bone flap is then mortised into the new bed and locked by slipping the lower end of the flap, which has been slightly shortened, under the overhanging shelf of bone (Fig. 6). It should be noted that the part of the ligament formed by scar tissue is brought against the denuded bone of the tibial head above the new bed. The inner surface of this part of the capsule should be scarified, so that in healing it will be firmly adherent to the bone and entirely eliminated from the shortened ligament.

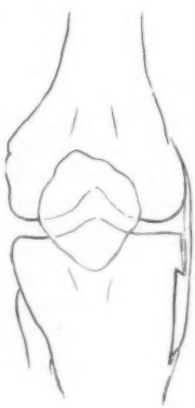

FIG. 6

Transplanted flap in position, showing the locking of the flap and the denuded portion of the capsule approximated to the raw bone above the flap.

The whole bone flap can be implanted forward on the new bed if one wishes to increase the obliquity of the anterior fibers of the ligament which might act as an additional check on any forward movement of the tibial head on the femur. This has not been necessary in any of the writer's cases.

The anterior and posterior incisions of the capsule are closed with catgut (Fig. 7). Plication of the capsule by overlapping of the edges of these incisions with mattress sutures would strengthen the inner side of the capsule if this was thought necessary. The skin is closed in the usual manner. A hinged cast is applied. The knee is kept quiet for the first two weeks and the patient is then allowed to be up with use of the leg and graduated exercises for the development of the quadriceps. Use of the hinged cast is advocated for six weeks.

FIG. 7

Suture of the capsule and fibrous covering of the flap.

The author has operated on five cases with excellent results.

CASE REPORTS

CASE 1. W. H. H., male, forty-nine years old, an iron worker, was seen on May 7, 1931, with a history of having severely injured the right knee in a fall from a scaffold eleven months previously. The patient had been treated by a cast and a knee cage for six weeks. Two months later, the cartilage had been removed, with no improvement. Physiotherapy and a brace had then been employed for four months, followed by the use

of an elastic knee support. The patient had been unable to return to work because of weakness and pain in the knee.

Examination of the right knee showed scar over the inner side of the joint and tenderness over the head of the tibia. The right thigh was one and one-half inches smaller than the left. There was motion in abduction with the knee extended to 25 degrees (estimated). The rocker test was negative. Roentgenographic examination was negative for bone injury.

At operation the internal lateral ligament was shortened by transplantation of the tibial attachment.

A cast was worn for eight weeks, followed by physiotherapy. The patient returned to work in four months.

Examination two years later showed a perfectly stable knee and full motions. The right thigh was half an inch smaller than the left.

CASE 2. M. C., a colored female, aged twenty-seven years, was first seen on October 5, 1931. The patient complained of a weak and painful right knee. She stated that three years previously she had fallen on the ice and had dislocated her knee. She had been treated by the family physician, who had applied a splint for two weeks, and who had also used local applications. No other treatment had been given. The knee had remained weak and had frequently given way. The patient had gradually become worse and had used crutches for the past fourteen months. At the time when she was seen by the author she was unable to bear weight on the leg.

Examination of the right knee disclosed marked atrophy of the thigh and calf. There was no real swelling of the joint and no tenderness. The knee could be fully flexed and extended actively. There was motion in abduction with the knee extended to 35 degrees. The inner surface of the tibia could be separated by two fingerbreadths. Definite anteroposterior movement of the tibia on the femur was present. There was contracture of the tendo achillis, so that the foot could not be flexed quite to a right angle. Roentgenographic examination was negative for bone injury.

A diagnosis of torn internal and crucial ligaments was made. On October 6, 1931, under gas anaesthesia, the contracted tendo achillis was stretched; the foot was brought up to just beyond a right angle; and a cast was applied. This cast was worn for ten days and then a hinged cast was applied. The patient was given exercises and encouraged to use the leg.

At the end of six weeks the patient was again seen, at which time she walked very well in the cast. The cast was removed and definite improvement in the musculature of the thigh and the leg was noted. There was still considerable lateral and anteroposterior play. The patient was advised to continue the use of the knee and exercises, and the inner side of the heel was elevated a quarter of an inch. The patient returned in two weeks and stated that the knee had given way several times and was painful. Examination at this time showed increase in fluid with some swelling of the joint.

On December 11, 1931, the cartilage was removed, and examination of the inner side of the joint showed that both crucial ligaments had been torn and had almost entirely disappeared. The internal lateral ligament was thinned in its lower part. The ligament was shortened by transplantation of the tibial attachment and by plication of the capsule along the anterior incision with mattress sutures.

A straight cast was worn for four weeks, after which a hinged cast was applied. Use of the knee was encouraged and exercises were employed for eight weeks. Seven months after operation examination showed the right thigh to be the same size as the left; there was still moderate anterior motion of the tibia on the femur when the knee was flexed.

In a communication eighteen months after operation the patient stated that she was working regularly as a cook and that the knee gave her no trouble.

CASE 3. R. G., male, a filling-station employee, was seen in June 1932, with a history of having injured the left knee four months previously when a truck had backed into him. The knee was badly bruised and swollen and had been bandaged by a local doctor for four weeks. During this time the patient had been on crutches. Roent-

genographic examination had disclosed no fracture. The knee had remained swollen and "wobbly", and the patient had used a cane ever since he had discarded the crutches.

Examination of the left knee revealed considerable swelling over the inner side of the joint and tenderness over the head of the tibia and the anterior end of the internal cartilage. There was abduction of 20 degrees of the tibia on the extended femur. There was limited extension of the knee to 10 degrees and motion in flexion to 110 degrees. The rocker test was negative. The left thigh was three-quarters of an inch smaller than the right. Roentgenograms showed definite spur formation at the inner margin of the head of the tibia.

At operation the internal lateral ligament was shortened. The internal semilunar cartilage showed a longitudinal tear (bucket-handle type). This cartilage was completely removed.

A hinged cast was applied and use of the knee and exercises were allowed after two weeks. The cast was removed after six weeks.

Examination fourteen months later showed a perfectly stable knee. The patient stated that he was playing semi-professional baseball.

CASE 4. P. L., male negro, thirty-two years of age, a stevedore, was first seen in October 1932 because of a "weak knee". He stated that nine months previously while at work his right leg had been caught in a "hoist" rope and he had been thrown into the hold of a ship. He thought that his knee had been pulled out of joint. He had been treated at the Marine Hospital and had worn a cast for four weeks. Three weeks later, the cartilage had been removed. He had been unable to work as the knee gave way and became painful.

Examination showed some swelling of the right knee with excess fluid in the joint and tenderness over the head of the tibia. There was abduction of 20 degrees of the tibia on the femur. Definite forward motion of the tibia on the femur was present. Roentgenographic examination revealed an increase of the joint space and irregularity of the tibial spine. No fracture was present.

The usual operative procedure was employed. On examination, the crucial ligaments were found to be intact but relaxed.

A hinged cast was applied and exercises were given for eight weeks.

Examination, six months later, showed a stable knee. The rocker test was negative. There was some soreness on prolonged use, but the patient was able to drive a delivery truck.

CASE 5. M. D., a white school boy, seventeen years of age, was first seen in June 1935. He had injured his left knee a number of times playing football, and the knee locked and swelled three or four times a month.

Examination showed a powerfully built young man; he weighed 230 pounds and his height was six feet, three inches. The left knee revealed some swelling, tenderness over the head of the tibia and the cartilage, some atrophy of the thigh, and slight lateral and anteroposterior play. The roentgenograms were negative for bone injury.

At operation through the Jones incision, the torn cartilage (bucket-handle type) was removed and after three weeks the patient was given exercises and was permitted to use the knee. Following operation, the knee remained weak and slipped back and forth in spite of exercises. Six months later, the knee continued to slip and to give way. Examination showed the quadriceps to be well developed; the left thigh was half an inch smaller than the right. There was motion in abduction with the knee extended to 15 degrees. The rocker test was positive.

In January 1936, the usual operation was performed. There was some drainage from the wound after one week. The knee was kept in a cast for nine weeks; hinges were not used. After removal of the cast the patient was permitted to use the knee and was given exercises.

Four months after the operation, examination revealed the thigh muscles to be still

somewhat atrophied, but the patient walked well. There was no lateral motion with the knee straight and no anteroposterior play.

This paper is offered to describe an operative procedure to remedy the instability of the knee due to injuries of the internal, lateral, and crucial ligaments. To the author it seems theoretically sound; mechanically it has proved simple but accurate, and in the few cases in which it has been used it has given satisfactory results.

MELORHEOSTOSIS LÉRI

A Case Report

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In 1922 Léri and Joanny reported a type of bone pathology previously undescribed, to which they applied the descriptive name of "melorheostosis" or "flowing hyperostosis of a limb". The characteristic lesion is revealed by roentgenograms which show a dense, eburnated, linear streaking of the bones of an extremity, often beginning in the scapula or pelvis and extending along one side of the long bones into some of the carpal or tarsal bones, causing Léri to liken the appearance to a candle flow. Only one extremity is ever involved in any individual, which suggested to Putti the name "osteosis eburnisans monomelica".

The clinical picture is not nearly so definite as the roentgenographic findings which really establish the diagnosis. The symptoms are indefinite and vague and serve chiefly to lead the physician to examine the skeleton roentgenographically.

Nineteen cases have been reported to date [2]; some were recorded as unidentified conditions, but they are now recognized under this classification. Eleven of the patients were males, the ages ranging from eight to fifty-four years. The right side was affected in twelve cases, and the upper extremity in the same number of cases.

The following case which has come under the observation of the authors is interesting because of its singular association with scleroderma superimposed upon the area affected in the bone and covering the same general pattern.

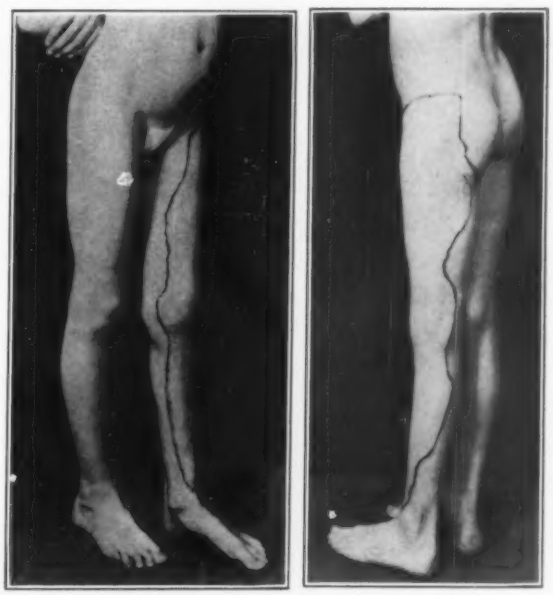

FIG. 1-A

Patient on admission.

FIG. 1-B

Area outlined is the delimitation of scleroderma.

FIG. 2

Roentgenographic appearance of the pelvis and left femur, revealing hyperostotic flow in the ilium and suggestion of cystic changes in the femur.

FIG. 3

Hyperostotic flow in the femur.

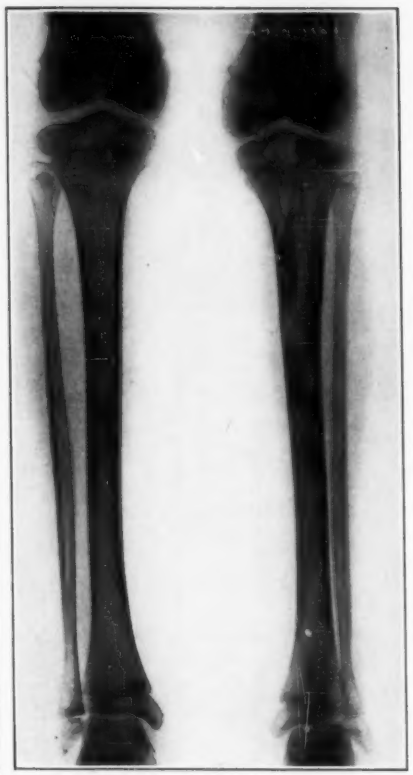

FIG. 4

Roentgenographic appearance of the tibia.

CASE REPORT

F. H., a white boy, ten years of age, entered the hospital on April 26, 1934, because of deformity of the left leg. He had been a full-term baby; the delivery had been uneventful; and infancy had been normal. When the patient was about six months of age a nurse had noticed that the left thigh was "hard", and soon afterward the left leg had become hard also. The condition affected the lateral aspect only. Between the ages of one and two years, this area had become "whiter", and at about five years the skin had become rough. Neither the boy nor the parents could remember exactly when the other symptoms had developed, but it seemed that he had always limped a little, and the mother thought "this was because his knee was stiff". A short time prior to hospitalization the patient had accidentally struck himself on the left thigh with a baseball bat; there had been no previous injury. After this accident, he complained of pain for the first time, crying that night and often thereafter. The mother said he "acted like a person with a cramp in his leg". He was taken to a local doctor who discovered the left lower extremity to be one inch shorter than the right; the parents and the boy had not been aware of this. On writing to the hospital one month later, this doctor said that the boy "is just recovering from an attack of acute lameness and pain in the left hip and knee accompanied by fever". Traction had been applied at home with relief; its removal always resulted in a return of the pain. The school teacher later told the mother that the boy had been crying with pain off and on all winter.

The physical examination was essentially negative except for the left lower extremity and a degree of malnourishment. Notes made on admission state: "There seems to be some pathology with reference to the left hip which discloses limitation of movement in all directions. There is thickening of the skin and subcutaneous tissue extending from the anterior superior spine of the ilium down to the foot, which restricts flexion of the knee (Figs. 1-A and 1-B). There is no complaint of pain on movement of the joints. Roentgenograms of the skeleton disclose radiating sclerotic bone shadows of the left ilium and a similar shadow at the head of the femur, and combination of cystic-appearing

FIG. 5

Showing extension of ostotic flow into the astragalus, scaphoid, and metatarsals.

areas and streaking osteosclerosis the entire length of the shaft of the femur and upper half of the tibia." Later roentgenograms showed similar involvement of the medial tarsal bones. (See Figures 2, 3, 4, and 5.) The left lower extremity revealed no atrophy, but there was one inch of shortening. Hematology and urinalysis were normal; the Kahn blood test was negative; blood calcium was normal; and the intradermal tuberculin test was not done.

The exact nature of this case was not recognized at first, but further observation and a review of the literature listed at the end of this paper made the diagnosis of melorheostosis Léri obvious. No treatment was given, and the patient was dismissed to return annually for observation. A biopsy was not done. The pain has subsided. There is no apparent change in the skin condition, and there is no increase in the shortening. The patient's general health continues to be good except that he is underweight.

DISCUSSION

This case is consistent with those so far reported in that it is impossible to obtain from the history a definite symptomatology suggesting a clinical syndrome. The most consistent feature is the vagueness of symptoms. The physical examination contributes very little to the making of a diagnosis. However, if the hip is the seat of trouble, the complaints of the patient may be enough to suggest Legg's disease, a condition which also often gives rise to symptoms which are vague but of sufficient importance to lead the orthopaedic surgeon to examine the patient roentgenographically.

Kraft has written more fully on this subject than anyone in this country, and Moore and De Lorimier have also reviewed the nineteen cases presented to date. We have drawn freely from their articles in outlining this brief review of the literature concerning this rare condition.

The earliest onset heretofore recorded was at the age of five years. In only four cases has the initial complaint come after the period of bone growth. The onset is insidious and the progress is slow. The symptoms are more pronounced in children, but the roentgenographic findings are less evident in them than in adults. Weakness and wasting of the affected extremity are usually found. Bowing of the bones is frequent and not in proportion to the lesion. Shortening or enlargement of the limb has been considered to be rare. There may be a slight limp. There is occasional stiffness of the joints, with some limitation of motion, but rarely does complete ankylosis occur. Indurated, erythematous areas may be found in the skin over the affected limb.

The most characteristic feature is indicated by the name,—flowing hyperostosis, extending along a part of or the full length of a limb, typically unilateral, and on one side of the bones. There may be circumscribed areas, but the typical roentgenogram shows a linear, irregular, rough or smooth, dense, proliferative excrescence extending along one side of the bone and usually missing the joints. In the lower extremity it often reaches from the ilium over and including the femur and tibia to one or two tarsal and metatarsal bones and phalanges. The lesions are eburnated, but the adjacent bone is often rarefied. In advanced cases, periarticular tissue becomes involved. Occasionally masses are found

extending into the soft tissues with pressure on veins and nerves and resulting oedema and pain. Fractures through the lesions have never been reported. The lesions do not seem to follow the course of blood vessels or nerves.

Histological examinations of material from five biopsies have revealed no characteristic appearance and the findings have not been in complete agreement. There is some increased vascular pattern, obliteration of vessel lumina in places, perivascular ossification, atrophic bone marrow rich in osteoblasts, and compactness of the lamellae. Islands of cartilage have been seen.

Kraft [1] has summarized the four theories that have been advanced as the etiology of this condition:

1. Putti suggested a vasomoter neurosis as being the etiological factor, citing the vascular and perivascular findings as evidence.

2. Léri supposed some infectious process to be the cause, and thought the skin lesions were a manifestation of the same process.

3. Some constitutional endocrine disturbance has been advanced as the basis, as evidences of hyperthyroidism and hypopituitarism were seen in two cases.

4. Zimmer has suggested that some embryonic defect, such as a metameric disturbance, offers an explanation, the idea being that the hyperostotic bands can be traced to a single truncal segment with the assumption that there was an embryonic lesion prior to the budding process of the limb.

There is no indication of a hereditary factor. The diagnosis is made by the characteristic roentgenographic picture, by the fact that the lesions involve one extremity, and by the absence of pathology and history suggestive of some other condition. Laboratory tests are of no value except for elimination purposes. Any treatment must be entirely symptomatic. Heat and massage often give relief from pain; mild analgesics may be used. One case seemed to "improve" when repeated roentgenograms were taken at one sitting. There is no record of any surgery in these cases. It is often important to reassure the patient that the condition is not serious.

There have been no post-mortem examinations in any of these cases. The general health of these patients has been good. No relation to tuberculosis, syphilis, or malignancies has been discovered. The proliferative process is slow and may be stationary for years. It usually does not involve the joints. Periods of remission of symptoms can be anticipated.

SUMMARY

The case of melorheostosis reported increases the preponderance of the cases involving males and makes the fifth case involving the left lower extremity. If the dermatological findings can be considered to be intimately connected with the bone pathology, the earliest onset of

known symptoms is placed at six months of age. The wide-spread scleroderma present in this case has not been hitherto reported and is particularly interesting in that the sclerotic area of the skin is directly superimposed over the sclerotic area of bone. The report of fever following the injury might be interpreted as giving support to the theory of an infectious process. Shortening, not often noted, was present. In this case, unlike those hitherto reported, there seem to be associated lesions in the upper end of the femur which suggest the appearance of osteitis fibrosa cystica.

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TREATMENT OF INTERCONDYLAR FRACTURES OF THE ELBOW BY MEANS OF TRACTION *

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Of all the fractures occurring in or around the elbow joint there are none that offer such perplexing problems of treatment as intercondylar fractures. Fortunately they are rare, for, despite careful treatment, most cases end in complete ankylosis of the elbow joint. In a recent paper, read before the American Academy of Orthopaedic Surgeons, James S. Speed emphasized the problems that confront the surgeon in dealing with this type of fracture which receives but scant attention in text-books on fractures.

The cause of intercondylar fracture is direct violence either from a fall or from a direct blow over the tip of the olecranon. If the force strikes obliquely either the capitulum, or the articulation for the head of the radius, or the trochlea, the articulation for the trochlear portion of the ulna is fractured and the elbow joint is completely disorganized in consequence. Worse still, when both articular areas are fractured the proximal end of the shaft of the humerus is wedged in between the fragments and may be forced into the elbow joint.

Inasmuch as muscle contraction is the direct cause of deformity in fractures of the long bones, one can readily appreciate that the most bizarre deformities must follow intercondylar fractures of the elbow because of the complex muscle attachments around the joint. Contraction of the triceps muscle posteriorly and of the biceps and brachialis anticus anteriorly is the chief cause of deformity following fractures which penetrate the elbow joint. In addition, the attachment of the pronators and flexors on the trochlea and of the supinators and extensors on the capitulum tends to exaggerate the deformity and to enhance the problem of treatment.

Intercondylar fractures of the elbow joint fall into two classes: T fractures and Y fractures. In most T fractures (Figs. 1-A and 1-B) there is a transverse fracture of the lower humeral shaft and a vertical fracture separating the articular areas. The proximal end of the shaft is driven between the articular fragments, completely disorganizing the elbow joint. Even if the distal end of the shaft of the humerus is not forced between the articular fragments, the fragments are driven backward and the angulation results in a dorsal displacement of the elbow joint, due to contraction of the muscles of the upper arm.

The Y fractures of the elbow joint are divided into two groups:

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 19, 1936.

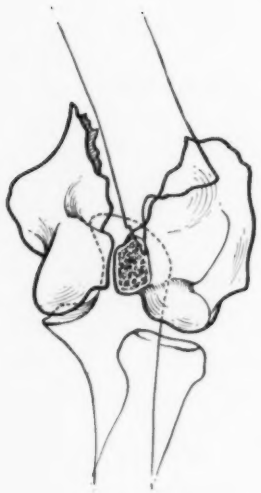

FIG. 1-A

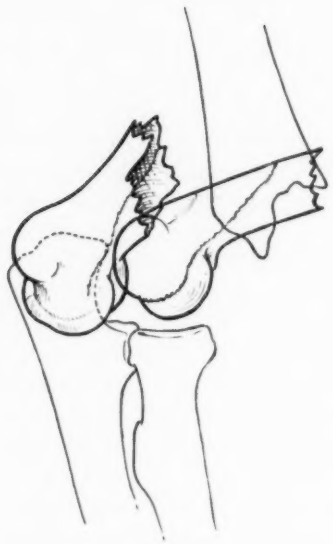

FIG. 1-B

Intercondylar T fracture.

Fig. 1-A: Anteroposterior view. Fig. 1-B: Lateral view.

fractures of the capitulum and fractures of the trochlea. When the capitulum is fractured (Figs. 2-A and 2-B), it is displaced upward and the head of the radius usually accompanies it, the ulna slipping in between the fractured capitulum and the trochlear portion of the articular area. When the trochlea is fractured (Figs. 3-A and 3-B), it is displaced upward, carrying with it the ulna and again disorganizing the elbow joint. In this type of fracture there is very frequently an injury to the ulnar nerve;

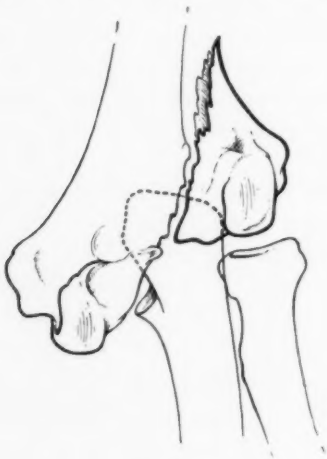

FIG. 2-A

FIG. 2-B

Intercondylar Y fracture, showing splitting off of capitulum.

Fig. 2-A: Anteroposterior view. Fig. 2-B: Lateral view.

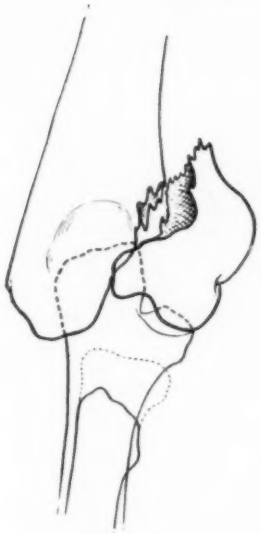

FIG. 3-A

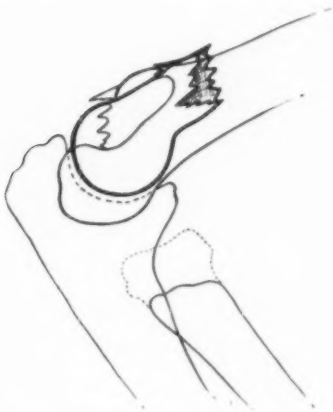

FIG. 3-B

Intercondylar Y fracture, showing splitting off of trochlea.
Fig. 3-A: Anteroposterior view. Fig. 3-B: Lateral view.

hence one must always test the ulnar distribution to determine the extent of the nerve injury.

In the treatment of intercondylar fracture one has no hesitation in recommending open reduction as the only procedure which offers any hope of complete functional restoration. The technique commonly advised is frank exposure of the fragments and the securing of the fractured portion with nails, screws, or bolts. Nevertheless, the results are unsatisfactory. This is undoubtedly due to the difficulty of reducing the fragments displaced by muscular contraction. Moreover, after the fragments have been brought into proper position, it is difficult to retain them by any form of artificial fixation. The foreshortening which results from the overriding of the fragments by the shaft must be corrected before the fragments can be approximated. This is accomplished by traction whereby the articular fragments are pulled into position past the distal end of the shaft and approximated to each other; the distal end of the shaft is then maintained in proper relation to the fragments. Sometimes a Kirschner wire is inserted through the olecranon process of the ulna, or a Kirschner wire or a Steinmann pin is driven through the distal fractured fragments of the humerus in the elbow joint. Even if this procedure does correct the overriding, one still encounters difficulty in properly approximating the articular fragments and in retaining them in proper alignment.

Bearing in mind the difficulties of treatment, the writer employed the following method of correcting a T fracture in which there was complete disorganization of the elbow joint with separation of the articular fragments by the distal portion of the humeral shaft. Old-fashioned ice tongs were employed in the traction. The medial epicondyle was exposed by an incision, two to three centimeters long, on the medial side of the elbow

joint. One prong of the tongs was inserted into the medial epicondyle and the incision was closed. The same procedure was employed on the outer side of the joint, the other prong being inserted into the lateral epicondyle and the tongs secured in place by means of the screw attachment on the tongs. A specially constructed Jones humerus splint (Fig. 4) was applied; the traction portion of the splint was extended downward for a distance of eighteen inches, instead of the two inches which one usually employs in using this splint. The end of the tongs was lashed to the traction end of the Jones humerus splint and the patient was allowed to walk about. Every few hours the tongs were tightened and traction was increased, the position of the fragments being noted by roentgenograms and by the fluoroscope. Should it be necessary to keep the patient recumbent, skeletal traction by means of the tongs can be employed with the aid of a Thomas arm splint (Fig. 5). A hinged right-angle extension with a block extension is attached, so that the position of the elbow joint can be controlled from the forearm while traction is applied.

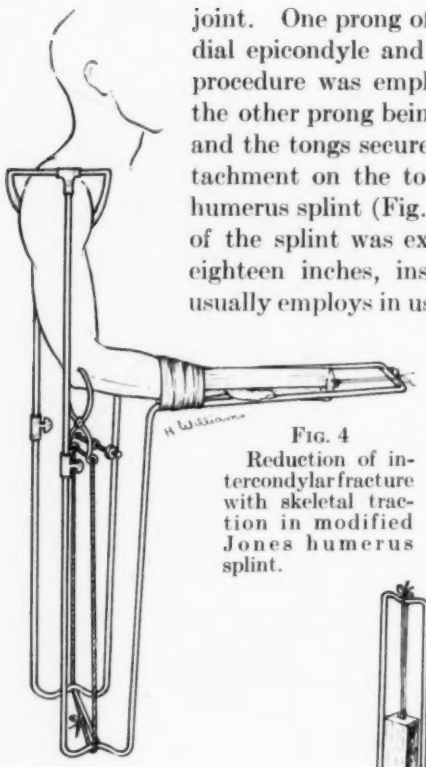

FIG. 4

FIG. 4
Reduction of intercondylar fracture with skeletal traction in modified Jones humerus splint.

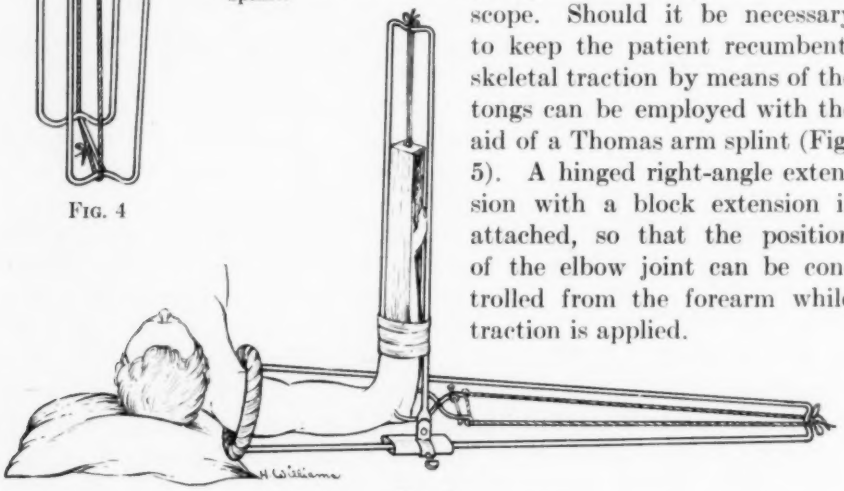

FIG. 5
Treatment of intercondylar fracture with skeletal traction in Thomas arm splint.

In the patients treated, overriding of the articular fragments by the shaft was completely overcome within thirty-six hours and then, by screwing the tongs more tightly, the fragments were approximated and the gap in the humeral articulation was eliminated. The end of the humeral shaft was then adjusted in position and, by means of forward traction on the forearm, the angulation deformity was overcome. This position was maintained by the modified Jones humerus splint for a period of approximately three weeks with very little difficulty, after which frequent roentgenograms showed that sufficient callus had formed to permit the removal of the tongs, but the Jones humerus splint was retained for

another two weeks. The arm was then placed in a sling and active motion was begun.

FIG. 6-A

Intercondylar T fracture.

FIG. 6-B

Intercondylar T fracture (lateral view) following skeletal traction.

FIG. 6-C

Intercondylar T fracture (anteroposterior view) following skeletal traction.

In treating Y fractures of the elbow, the same method is employed. In the case of a fracture of the trochlea with upward displacement of the

FIG. 6-D

Intercondylar T fracture. End result following skeletal traction.

FIG. 7-A

Intercondylar Y fracture of trochlea. (Head of radius removed eight months previously following comminuted fracture.)

medial articular portion of the humerus, one prong of the tongs is inserted into the medial condyle through a small incision which lays bare the epi-

FIG. 7-B

Intercondylar Y fracture of trochlea (lateral view) following skeletal traction.

FIG. 7-C

Intercondylar Y fracture of trochlea (anteroposterior view) following skeletal traction.

FIG. 7-D

Intercondylar Y fracture of trochlea. End result.

condyle. The other prong is then inserted into the lateral epicondyle in a similar manner. The same type of Jones humerus splint, with unusually long traction attachment, is applied. In this type of fracture, instead of straight downward traction, the tongs are forced toward the lateral trochlear portion of the elbow joint. In this way the displaced fragment is approximated in proper position to the capitulum and is drawn down into proper alignment until sufficient callus has formed to render traction by the tongs superfluous, and later the Jones humerus splint can be removed.

In fractures of the capitulum, with complete upward displacement of the fragment, the same principle is employed. In this, as in the other types of fracture, the tongs are first inserted into the medial epicondyle to avoid injuring the ulnar nerve. The tongs are forced medially until the capitulum has been brought down into proper alignment with the trochlea and the gap in the articular face is closed.

This method of producing traction by ice tongs has been employed in treating six patients, all showing simple fractures. Five of the patients were males. Of these six patients, four presented the T type of intercondylar fracture and two the Y type. The one female patient exhibited a T fracture. Of the two Y fractures, one involved the trochlea and the other the capitulum. Of the six patients, good results were obtained in three; two of these patients had T fractures and the third, a Y fracture. Fair results were obtained in two cases, one of which was a T fracture and the other a Y fracture. In the case of the one female patient, the result was a complete failure, owing to the fact that both articular fragments were so badly comminuted that satisfactory purchase on the epicondyles by the tongs was impossible. In treating this patient the device was abandoned.

COMMENT

Six instances of intercondylar fracture are reported in this paper, together with end results, the object being to suggest a new device in the treatment of a very intractable type of fracture. The recital of end results is merely an incident in the presentation.

None of the fractures treated was compound. In compound fractures the immediate application of ice tongs is contra-indicated. A delay of five to ten days, or until the fracture has been converted into a simple fracture, before skeletal traction is resorted to is most important. As a matter of fact, in all instances of intercondylar fracture there is severe swelling and ecchymosis, and no harm results from deferring application of the tongs until the tissue resistance has been restored. Traction by ice tongs is also contra-indicated in cases where there is such marked comminution of the intercondylar fragments that the prongs do not gain purchase when applied. Infection in or around the elbow joint is obviously also a contra-indication to the use of this method of correction.

Although intercondylar fractures of the femur are not specifically considered, it should be reported that the writer has successfully employed this method of treatment for that type of fracture.

THE SELECTION OF THE ANAESTHETIC IN CASES OF FRACTURE OF THE JAW

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In traumatic injuries to the face, particularly in those which include maxillary fractures, the necessity of immediate surgical procedure frequently has a tendency to relegate the choice of anaesthesia to the realm of pure routine. This circumstance is most unfortunate, for the involved area will almost invariably affect, directly or indirectly, either the alimentary or the respiratory tract or both; therefore, the anaesthetic used must be one that will cause the least embarrassment to the normal functioning of these tracts. It should be remembered, too, that the anaesthetic must offer complete effectiveness during the operation, but must avoid, to the greatest extent possible, additional discomfort and suffering on the part of the patient. A stormy postanaesthetic period will greatly impede recovery.

As pertinent to the choosing of an anaesthetic, Lundy enumerates the following factors:

1. The patient's mental and physical condition;
2. The proposed operation;
3. The technique of the surgeon;
4. The requisite of anaesthesia or of analgesia;
5. The necessity for relaxation;
6. The need of quiet breathing;
7. The quick recovery of reflexes;
8. The likelihood of the production of immediate or delayed untoward results.

In cases where the mandible has been fractured and immobilization by wiring is indicated, considerable controversy has arisen over the question of wiring the jaws while the patient is under a general anaesthetic Among others in favor of this method is Hensel who cites a series of eighteen cases of immediate fixation of the mandible under general anaesthesia in which no complications from vomiting occurred. He states that the depth of the anaesthesia need not be great. Since in general anaesthesia there are usually three recognized stages—a primary (analgesic) stage, a secondary (excitement) stage, and a third (surgical) stage—it is assumed that he refers to one of the first two.

The author's own experience with wiring the jaws while the patient is anaesthetized and unconscious, however, has not recommended the continued use of this method. In a number of instances where the jaws were immobilized with the patients under a general anaesthetic it was very difficult to obtain and maintain satisfactory occlusion. In addition

to the usual difficulties encountered, there were three cases of near fatalities,—two patients swallowed their tongues and a third developed pneumonia. Where conditions indicate general anaesthesia, and immobilization by wiring is the chosen method of fixation, the writer considers it feasible to place the eyelet wires in their respective positions, but advisable to refrain from completing intermaxillary fixation until the patient has regained consciousness and has recovered fully from the effects of the anaesthetic.

In uncomplicated fracture cases where there has been no untoward elapse of time, the author prefers local anaesthesia. The best results have been obtained with pre-anaesthetic medication and a few drops of a 1-per-cent. solution of novocain injected high in the mucobuccal fold in the region of operative activity. This utilization of local infiltration, beside being completely adequate, provides most essential and efficient cooperative measures. It leaves the patient free to shift his position at will, thereby permitting him to assist in supplying countertraction when needed. Of even greater importance is the necessity of complete muscular relaxation in securing good alignment of the fragments. This may be achieved with intramuscular injections of novocain to a degree equalled by ether administration only in a state of complete narcosis, a condition scarcely warranted by the type of operation.

It is conceded that the employment of general anaesthesia is necessitated under certain circumstances. In fracture cases where the initial treatment has been delayed until fibrous union has taken place, or where extensive surgery of the bone and soft tissues is required, general anaesthesia is the method not only of choice but of necessity. Similarly, local anaesthesia is definitely contra-indicated in the case in which infection has already occurred, for there is the serious possibility of carrying the infection into the deeper soft-tissue structures and also of endangering the bone itself. In these instances the writer has made use of ether, rectal avertin, and a combination of avertin with novocain. Of the first two, it is the author's opinion that the rectal avertin is unquestionably superior, primarily because of the following facts:

1. The anaesthetist is out of the operative field;
2. Respiration is regular and normal;
3. Reduction is accomplished without untoward results which follow the use of an inhalation anaesthetic;
4. There is early relaxation of the muscles of the jaws and tongue;
5. The supplemental employment of an inhalation anaesthetic is avoided;
6. The dangers of explosion connected with the use of the cautery are obviated.

When ether is to be used, the condition of the patient must be considered carefully both before its administration and during the period of recovery from its use. Especially in cases where the operative field is the jaw, the possibility of postoperative vomiting and its effects may not be

dismissed lightly. Some operators insist upon the complete emptying and washing of the stomach before the ether is given. This precaution, while of undoubted value systemically, will almost certainly bring about a mental state approaching hysteria in the person already suffering from shock. The reaction most frequently found is the fear of "dying under the ether". While the patient's mental attitude before the operation is deserving of sympathetic consideration, the surgeon must weigh carefully the numerous factors which are going to influence both the progress and the results of his surgery if it is to be undertaken in conjunction with an inhalation anaesthetic. For his own part, he is fully aware of the difficulties of working over a mouth from which ether vapor is being given off.

Among the items of direct significance in regard to the patient are:

1. Possible asphyxia and suffocation caused by the swallowing of the tongue, or by the mouth and stomach secretions in the respiratory tract;
2. Greatly increased salivary secretion;
3. Possibility of cyanosis produced by faulty position of the head;
4. Effect of cough reflex on aspiration, gagging, etc.;
5. Postoperative shock and fatigue;
6. Danger of pneumonia;
7. Impossibility of confining effects of anaesthesia to regional parts;
8. The extended time factor in recovery caused largely by effects and consequences of postoperative vomiting. Not only is the systemic reaction to ether involved, but the retching and struggling with the jaws immobilized may necessitate the immediate cutting of the tie wires. Also, this involuntary strain creates a grave possibility of displacing fragments and of loosening fixation which otherwise would have permitted normal union.

Of importance from the standpoint of the hospital are the increased costs of operating under general anaesthesia, the greater risk of fatalities, and the greater amount of postoperative nursing care required. In connection with this last item, experience has convinced the writer that it is essential to maintain constant nursing care until the patient has fully recovered consciousness.

CONCLUSIONS

In uncomplicated fractures of the jaw, local anaesthesia has been found to be completely adequate. At the same time, it offers distinct advantages over general anaesthesia. The negative factors common to the use of a general anaesthetic, particularly when of the inhalation type, are eliminated. It is recognized, however, that serious and involved conditions, including the presence of infection, will necessitate the use of general anaesthesia. In these cases the author's preference is rectal avertin.

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SACRARTHROGENETIC TELALGIA

IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis

BY HORACE C. PITKIN, M.D., SAN FRANCISCO, CALIFORNIA

This article is the fourth of a series of five.* It is based upon further statistical analyses of the 650 records used in the second article. Its scope is limited to a study of sacrarthrogenetic scoliosis, and its purpose is to show that the pattern of the scoliosis is a valuable guide to a better understanding of the pathological changes that occur in the upper sacral joints.

In beginning the statistical study, we eliminated all cases in which there was a measurable inequality in the length of the lower extremities and those in which there were obvious structural derangements, either in the internal balance or in the external muscular support of the presacral vertebral column. We next subjected eighty items of positive or negative evidence noted in the physical examination of each case to the scrutiny of statistical machinery,** each item being compared with every other item in an attempt to determine any primary fixed relationships among them. Many tendencies were noted, but no fixed rules could be discovered by this method. Three items in this study deserve mention:

1. In reviewing the literature, we found a general impression that the trunk lists away from the side of the chief complaint in approximately 60.0 per cent. of cases. In each of our cases, the list was determined with a plumb-line, and the figures are: heterolateral list, 45.0 per cent.; homolateral list, 47.0 per cent.; no list, 8.0 per cent. We noted, however, that spectacularly large excursions tended to appear more frequently in the heterolateral list,—a condition that may cause the observer to accord numerical superiority to the deviation which more often arrests his attention.

2. Relaxation of the gluteal muscles, lowering of the buttock, and subsequent atrophy of the buttock have been noted in cases that showed sacrarthrogenetic telalgia. In each of our cases the relative height of the inferior margins of the buttocks was determined with a spirit-level. In 55.0 per cent. of our cases there was a lowering of the gluteal fold on the side of the chief complaint; the relationship was heterolateral in 28.0 per cent., and the buttocks were level in 17.0 per cent. In other words, if the level of the buttocks is unequal, the chances are approximately 2 to 1 that the lower buttock is on the side of the chief complaint.

* Three articles have been published under the same title.[2] The fifth is now in preparation and will deal with the treatment of cases in which sacrarthrogenetic telalgia is present.

** For the use of this equipment we are indebted to the Powers Division of the Remington-Rand Company.

3. In each of our cases the relative height of the shoulders was determined with a spirit-level. The figures for the relationship of the lower shoulder to dorsal scoliosis are: heterolateral relationship, 80.0 per cent.; scoliosis present, but shoulders level, 3.0 per cent.; scoliosis absent, but shoulders not level, 9.0 per cent.; homolateral relationship, 8.0 per cent. Thus, if the level of the shoulders is unequal, the chances are almost 10 to 1 that a dorsal scoliosis is present. Furthermore, if a dorsal scoliosis is present, the chances are 10 to 1 that the convexity of the curve is on the same side as the higher shoulder. These facts have been noted many times in the literature, but we repeat them because they are of value in the determination of doubtful curves.

In our next investigation, we combined groups of two or more items that showed definite numerical relationships and subjected these groups to comparative study in the statistical machines. These studies produced figures of 90.0 per cent., and upward, to justify the following three conclusions:

1. In normal subjects, the production of any type of scoliosis by voluntary muscular effort regularly is accompanied by pelvic torsion.* This torsion is associated with a tilting of the sacrum toward the ilium that shows the smaller angle of inclination, and toward the apex of the lateral curve of the lumbar spine. More simply stated: right or left pelvic torsion normally is associated with a homolateral curve of the lumbar spine.

2. In normal subjects, the reflex muscular response initiated by an experimental lengthening of one lower extremity reverses this relationship, apparently in an attempt to correct the fixed lumbar curve.** Under these conditions, right or left pelvic torsion is associated with a heterolateral curve of the lumbar spine.

3. In sacrarthrogenetic scoliosis, either of the above relationships of lumbar curve to pelvic torsion may be present in the habitual stance. The heterolateral relationship, however, regularly is associated with many other evidences of a disturbance in the function of the upper sacral joints.

Thus, in normal sacro-iliac function, we see that the lumbar curve always reflects the tilt of the sacrum which, in turn, reflects the pelvic torsion. If one alters the factor of sacral position (in relation to the constant plane of the horizon) and produces an abnormal lateral tilt by experimentally lengthening one lower extremity, the lumbar curve reflects the abnormal sacral tilt, but it does not reflect the pelvic torsion. If the factor of pelvic torsion is altered by abnormal iliac mobility, such as was shown by the case reported in the third article of this series, the lumbar

* For the sake of brevity, we use the term "pelvic torsion" to indicate antagonistic motion of the two ilia about a horizontal transverse axis that passes through the symphysis pubis. "Right torsion" indicates that the right ilium shows a smaller angle of inclination than the left, and *vice versa*.

** A detailed description of the changes produced by experimentally lengthening one lower extremity was presented in the second article of this series.

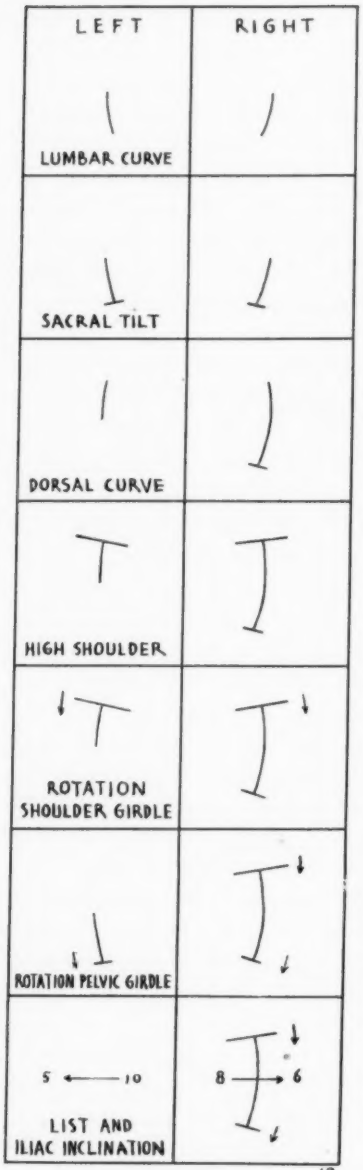

FIG. 1

FIG. 1

A simple method of measuring and recording sacrarthrogenetic scoliosis.

The author suggests the following routine procedure: Request the subject to stand "at ease" with the hands at the sides and with the unshod feet about three inches apart. Expose the entire back and the lower extremities. Palpate and *mark out* the dorsal, lumbar, and sacral spinous processes. Record the lumbar and dorsal curves just as they appear from the marks on the back. Note and record the tilt of the sacrum and, if it differs from the lumbar curve, recheck the markings of both. (In our experience, the failure of the two to coincide indicates a sacrolumbar disturbance.) Note and record the level of the shoulders and, if the high shoulder is not on the same side as the convexity of the dorsal curve, recheck the marking of the latter. (In our experience, the chances are 10 to 1 that the high shoulder will coincide with the dorsal convexity.) To measure the rotation of the shoulder girdle, place a ruler or other straight edge upon the floor in contact with the subject's heels; take one end of a three-foot tape or string in each hand and, holding it taut and horizontal, bring it into light contact with the skin over the spines of the subject's scapulae; sight downward across the tape and compare its position with that of the ruler on the floor. Record the shoulder that tends to be rotated backward behind the plane of the heels. The rotation of the pelvic girdle is measured and recorded in a similar manner, except that the tape is held in contact with the most prominent portions of the buttocks. If marked atrophy of one or both buttocks makes these landmarks unreliable, the tape may be held behind and parallel to a line joining the posterior superior iliac spines. Measure the list by dropping a plumb-line through the intergluteal fold. If the spinous process of the seventh cervical vertebra (vertebra prominens) lies completely to one side of the plumb-line, record a list to that side. (Frequently, a lateral shift of the pelvis is present, as indicated by the fact that the plumb-line does not fall midway between the heels. This shift may be recorded by a horizontal arrow placed below the rest of the pattern.) The iliac inclination is measured with an inclinometer and is recorded in degrees on the appropriate side of the pattern.

curve still reflects the sacral tilt, but it does not reflect the pelvic torsion. Therefore, we may state our first two diagnostic rules:

1. If the lumbar spine is normal, the lumbar curve reflects the position of the sacrum. It will be noted that this rule applies, not only to a lateral tilt, but also to the forward tilt of the sacrum which is reflected in the lumbar lordosis.

2. If the lumbar spine is normal, and if the lower extremities are equal in length, the lumbar curve normally reflects the pelvic torsion. A reversal of this relation indicates abnormal mobility of the sacro-iliac joints.

In all of our cases of sacrarthrogenetic scoliosis, we have recorded certain findings at each examination in the form of a simple diagram.

The method is shown in Figure 1. These diagrams are convenient, not only in checking the progress of a single subject, but also in grouping records that show like patterns of scoliosis. If one arbitrarily selects left-lumbar scoliosis as a constant and combines it with the four variables—dorsal scoliosis, rotation of the shoulder girdle, rotation of the pelvic girdle, and list of the trunk—sixteen combinations are produced. (See Figure 2.) The sixteen combinations of right-lumbar scoliosis with the same four variables are, of course, mirror-images of the left-lumbar patterns. By reversing all of the findings in cases that showed a right-lumbar curve, we grouped our records into the sixteen patterns illustrated in Figure 2, and continued the statistical study of the individual groups.

This study immediately focused our attention upon two patterns of

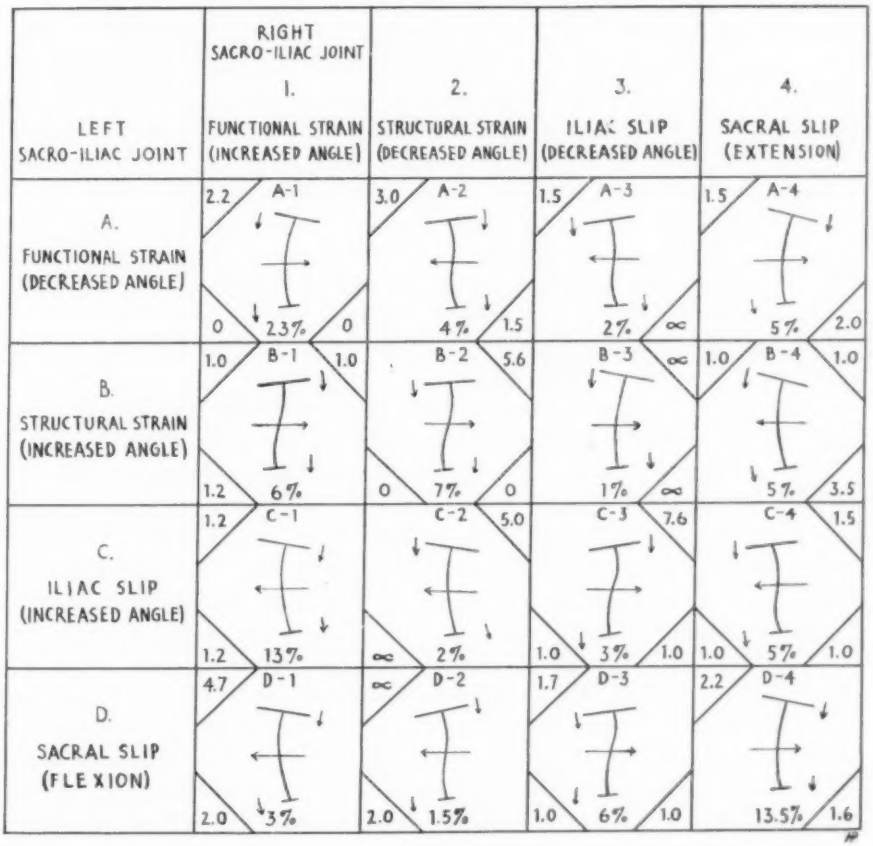
RIGHT SACRO-ILIAC JOINT
1. FUNCTIONAL STRAIN (INCREASED ANGLE)
2. STRUCTURAL STRAIN (DECREASED ANGLE)
3. ILIAC SLIP (DECREASED ANGLE)
4. SACRAL SLIP (EXTENSION)
LEFT SACRO-ILIAC JOINT
A. FUNCTIONAL STRAIN (DECREASED ANGLE)
B. STRUCTURAL STRAIN (INCREASED ANGLE)
C. ILIAC SLIP (INCREASED ANGLE)
D. SACRAL SLIP (FLEXION)
2.2 A-1 0 23% 0
3.0 A-2 4% 1.5
1.5 A-3 2% ∞
1.5 A-4 5% 2.0
1.0 B-1 1.0 1.2 6%
B-2 5.6 0 7% 0
B-3 ∞ 1% ∞
1.0 B-4 1.0 5% 3.5
1.2 C-1 1.2 13%
C-2 5.0 ∞ 2%
C-3 7.6 1.0 3% 1.0
C-4 1.5 1.0 5% 1.0
4.7 D-1 2.0 3%
∞ D-2 2.0 1.5%
1.7 D-3 1.0 6% 1.0
2.2 D-4 13.5% 1.6

FIG. 2

Left-lumbar sacrarthrogenetic scoliosis. The figure beneath each pattern indicates the incidence per cent. of that pattern in this series. The figure in the upper corner of each frame shows the chances (related to unity) that prevailed in this series of finding the named pelvic torsion on the side indicated. The figure in the lower corner of each frame shows the chances of altering the pattern by manipulative rotation of the pelvis toward the indicated side and will be discussed in the final article of this series. The sixteen patterns of right-lumbar sacrarthrogenetic scoliosis are mirror-images of the left-lumbar patterns (*1-A*, *2-B*, *3-C*, *4-D*, etc.).

scoliosis (Fig. 2, *A-1* and *B-2*). "Transitional scoliosis" is the term used to describe the single curve that shows a rotation toward the convex side,[1] but we have not found in the literature any name for the double scoliosis that shows a rotation toward the concavity of each curve. Since these two patterns in our series have shown the same fundamental significance, we feel that they should bear in common the title by which the single curve already is known, and that they should be designated as "single" and "double" transitional scoliosis.

We make a practice of gently manipulating the spine and sacral joints as a part of our routine physical examination. Whenever sounds are obtained that seem to indicate a sudden alteration in the position of the upper sacral joints,* we immediately reexamine the subject in the standing position and record any change in the pattern of the scoliosis, as well as the direction of the manipulation that produced the sounds. The same procedure is followed in therapeutic manipulations, unless an anaesthetic has been used that prohibits the assumption of the erect position. Our figures show that manipulation frequently changes other types of scoliosis into one of the transitional patterns, but a reversal of this phenomenon never has occurred. Moreover, when manipulation of any type of sacrarthrogenetic scoliosis initiates a rapid and uneventful recovery, the first examination after manipulation regularly shows a transitional pattern or an incomplete pattern. Finally, three types of subjects show transitional scoliosis with great regularity:

1. Normal individuals who are in the act of performing lateral bending or rotation of the trunk;

2. Patients who show an early stage of acute (specific or non-specific) arthritis of the spinal or upper sacral joints;

3. Patients who show acute, uncomplicated sprains or strains of the pelvic or spinal muscles.

Unequal (voluntary or reflex) action of the muscles that control the spine and the upper sacral joints is the obvious common denominator in these three groups. On the basis of these observations, we may state a third diagnostic rule:

3. Transitional sacrarthrogenetic scoliosis reflects the presence of unequal, reflex, muscular action and denies the presence of a sacro-iliac slip.

In any joint, a dislocation (or a subluxation) consists of a fixed pathological position and a sprain. Restoration of the normal relationship of the joint surfaces reduces the injury to the status of a simple sprain, plus a variable amount of traumatic arthritis. A sprain (or a strain) initiates painful stimuli which travel centrally in the nerves that supply the injured ligaments. These stimuli may cause telalgia, if they affect spinal segments other than the ones that correspond to the derma-

* Sounds of sacro-iliac origin, in our experience, characteristically are low in pitch, possess a muffled resonance, and seem to come from within the deeper portions of the pelvis, as if the bony ring acted as a sounding-board. Sounds that originate in the sacrolumbar and other spinal joints usually are higher in pitch, sharper, and more superficial.

tomes that cover the injured joint, but they invariably initiate reflex muscular action. Reflex spasm results in certain "protective" attitudes. In 404 (100.0 per cent.) of our patients who complained of sacrarthrogenetic telalgia, a complete scoliotic pattern was present as a part of the protective attitude. Of the 506 records used in our "abnormal group", 468 (92.0 per cent.) showed a complete scoliotic pattern.* A pattern was considered to be incomplete if any one of the four fundamental variables (lumbar curve, list, rotation of the shoulder girdle, and rotation of the pelvic girdle) was absent. Of the 144 college entrants in the "normal" group, 120 (83.0 per cent.) showed incomplete patterns in normal stance.

In the sixteen patterns illustrated in Figure 2, left-lumbar scoliosis is a constant, and it follows from our first rule that the direction of the lateral tilt of the sacrum also is a constant. Therefore, the position of the sacrum in relation to the two ilia is reflected in the inclinometric measurements of the variable pelvic torsion, provided that the symphysis pubis is intact. In the single transitional pattern (Fig. 2, *A-1*), our measurements show: left torsion, 35.0 per cent.; torsion less than 2 degrees, 49.0 per cent.; right torsion, 16.0 per cent. In other words, the chances are 2.2 to 1 that, if torsion is present, the normal condition of a homolateral lumbar curve will prevail. By applying our second rule to this pattern, it appears that the sacrum tends to maintain its normal relationship with the ilia, and the structural integrity of the sacro-iliac joints usually is preserved. Therefore, we may state a corollary to our third rule:

3-a. If the lumbar spine is normal, the single pattern tends to appear when function alone is disturbed.

The opposite condition was found in the double transitional pattern (Fig. 2, *B-2*), in which the figures are: left torsion, 9.0 per cent.; torsion less than 2 degrees, 41.0 per cent.; right torsion, 50.0 per cent. In this pattern, the chances are 5.6 to 1 that, if torsion is present, the abnormal condition of a heterolateral lumbar curve will prevail. By applying our second rule, we see that the failure of the sacrum to follow the motion of the ilia is a measure of the structural inadequacy of the sacro-iliac ligaments. Therefore, the second corollary to our third rule is:

3-b. The double pattern tends to appear when both structure and function are disturbed.

The case of alternating scoliosis which we reported in the third article of this series clearly showed the changes that occur in the relative positions of the sacrum and the ilia as the result of iliac slips. The fixed, abnormal position, together with the reflex action of the pelvic and spinal muscles, resulted in a "structural" pattern of scoliosis (Fig. 2, *C-3*). The figures in our series verify the findings in that case and show: left torsion, 8.0 per cent.; torsion less than 2 degrees, 31.0 per cent.; right tor-

* Twenty-six triple curves, four quadruple curves, and one quintuple curve are not included in this number.

sion, 61.0 per cent. The chances are 7.6 to 1, in the structural pattern, that the torsion will not be reflected in the lumbar curve. This evidence of a structural disturbance in the sacro-iliac joints indicates that the accepted term "structural scoliosis" applies to the sacrum and to the presacral spine with equal accuracy. Our fourth diagnostic rule is:

4. Structural, sacrarthrogenetic scoliosis is produced by an iliac slip.

If one excepts the single transitional pattern, the scoliosis most frequently encountered in our series is the "functional" curve (Fig. 2, *D-4*). Unlike the functional scoliosis produced by a short leg, the sacrarthrogenetic pattern tends to show the normal conjunction of pelvic torsion with a homolateral lumbar curve. The figures are: left torsion, 37.0 per cent.; torsion less than 2 degrees, 46.0 per cent.; right torsion, 17.0 per cent. Our manipulative work regularly shows that the sacrum and the ilia are abnormally fixed in this apparently normal position. Mirror-images of this pattern never have been seen in one subject, but careful roentgenographic measurements of many subjects have demonstrated the mechanism of production.* In this pattern, the structural integrity of the sacro-iliac joints tends to be preserved. The sacrum tends to follow the normal motions of the ilia. At some point in the arc of the iliac excursion, usually at one extreme of normal motion, the sacrum moves about its own transverse axis, slips, and locks the joint. The excursion of the sacral slip usually is too small to alter the relations of the sacro-iliac articulation in a measurable degree, and the figures show that the chances are 2.2 to 1 in favor of the normal relationship of torsion to lumbar curve. Thus, we see that the accepted term "functional scoliosis" retains its significance in the sacrarthrogenetic pattern. Our fifth diagnostic rule is:

5. Functional, sacrarthrogenetic scoliosis is produced by a sacral slip.

The four "primary" patterns (the two transitional, the structural, and the functional) constitute 46.5 per cent. of the 468 records of scoliosis in our series. Each of the remaining twelve patterns has been observed in at least five instances (1.0 per cent.). Each pattern has been given a position in Figure 2 in accordance with the recorded pelvic torsion and the direction of the manipulation that altered the pattern. It seems to us unnecessary to name each of these patterns, or to describe each of them separately, since they represent varying combinations of the etiological factors that we have noted in our study of the four primary patterns. Therefore, we shall group them under the generic title of "secondary" patterns.

Patterns *B-1* and *A-2* deserve special consideration. Although they are produced by the same disturbances of structure and of function that are found in the transitional curves, manipulation shows that *B-1* and *A-2* differ from the transitional patterns (*A-1* and *B-2*) in reflecting a fixed pathological position. The reason for this difference becomes apparent when we note that the inclination of both ilia increases in *B-1* and

* This was discussed in the second article of this series.

decreases in *A-2*. In other words, the motions of the two ilia in each pattern are agonistic. Agonistic iliac motion in the normal subject produces flexion and extension of the pelvis about the hip joints and is reflected in an increased or a decreased lumbar lordosis, but it does not cause scoliosis. Since it does not reflect antagonistic iliac motion, the lateral curve of the lumbar spine in *B-1* and *A-2* reflects a pathological sacral tilt. However, we have seen, in the study of normal subjects, that reflex action tends to compensate for a tilted sacrum by producing antagonistic iliac motion. Thus, if both sacro-iliac joints were freely movable, the pathological sacral tilt would excite reflex pelvic torsion, and pelvic torsion would transform *B-1* and *A-2* into transitional patterns (the type being dependent upon the relative prominence of the functional and the structural elements in the disturbance of the two sacro-iliac joints). Therefore, a fixed position of the sacrum is necessary in the production of *B-1* or *A-2*. Our experience indicates that these two patterns tend to appear most frequently in cases where the effects of a recent strain in one sacro-iliac joint have been superimposed upon the presence of an ancient slip in the opposite joint. Our sixth diagnostic rule is:

6. Secondary patterns of sacrarthrogenetic scoliosis are produced by a sacro-iliac slip on one side, combined either with a sl[illegible] or with a strain in the opposite sacro-iliac joint. Sacrolumbar complications tend to reverse the pelvic torsion.

Disturbances in the structure and in the function of the sacrolumbar joint were present in fifty-seven (11.0 per cent.) of our cases. These records were studied separately and were classified as follows: sprain, strain, or arthritis, twenty-eight cases; unilateral apophyseal subluxation, eighteen cases; prespondylolisthesis, six cases; spondylolisthesis,* five cases (one of which was unilateral). One case of prespondylolisthesis and the case of unilateral spondylolisthesis showed the structural pattern (Fig. 2, *C-3*), but the pelvic torsion was reversed, so that the smaller iliac inclination appeared on the same side as the lumbar curve. Ten cases of unilateral apophyseal subluxation showed the functional pattern (Fig. 2, *D-4*), but with the pelvic torsion reversed, as if the lower extremities were unequal in length. Two cases of symptomless spondylolisthesis were complicated by recent sacro-iliac slips. The presence of the spondylolisthesis did not affect the interpretation of the sacrarthrogenetic scoliosis, and the reduction of the sacro-iliac slips relieved all symptoms. After reduction, these two cases did not differ from the remaining forty-three cases that showed the single transitional pattern (Fig. 2, *A-1*). The three patterns that were seen in cases of uncomplicated sacrolumbar disturbance are identical with those that regularly are noted in the literature relating to disturbances in the balance of the presacral vertebrae. Therefore, despite the small number of cases in this series, we feel justified in stating a seventh diagnostic rule:

7. Uncomplicated disturbances in the structure and in the function

* These cases were eliminated in the earlier studies.

of the sacrolumbar joint produce only the three primary patterns of scoliosis (structural, functional, and single transitional) that are characteristic of vertebral dysfunction in general.

The differential diagnosis between sacrolumbar and sacro-iliac conditions, in cases that show a structural pattern, depends upon the determination of the pelvic torsion, for it appears that this pattern cannot be of sacro-iliac origin, if the normal homolateral relation of torsion to curve is present. In cases that show a functional pattern, the differential diagnosis apparently can be made without additional data, since roentgenographically demonstrable sacrolumbar subluxations were present in 91.0 per cent. of the functional patterns in which a heterolateral relation of torsion to curve was present. In the single transitional pattern, the problem is more difficult, for the chances are only 2.6 to 1 in favor of a sacro-iliac dysfunction, and there usually is very little pelvic torsion or ligamentous tenderness to guide the examiner.

The average number of tender points is higher in the structural pattern (3.6 per case) and lower in the first transitional pattern (0.9 per case) than in any of the other fourteen patterns.* When other aids to diagnosis fail, the injection of small amounts of procaine (one or two cubic centimeters of a 2-per-cent. solution) into one of the tender ligaments often produces a transient aggravation of the telalgia, in part or *in toto*, which is followed by a variable period of relief from pain. The aggravation of the telalgia apparently is due to an increase in the ligamentous tension produced by the injected fluid and seems to be directly proportional to the speed of injection. Rapid injections also may cause spasm to appear in individual groups of muscles. As the anaesthetic effect of the procaine becomes evident in the relief of the telalgia, the spasm of certain muscles may be seen to relax. Even when no gross change in the visible spasm is noted, there may be marked changes in the amount of the latent spasm, as demonstrated by an altered excursion in one or more of the manipulative tests. If one has an accurate mental picture of the exact anatomical structure in which he is depositing the procaine, and if he avoids injections in the vicinity of large nerves, the positive or negative evidence produced by this simple test is of great value.**

It may be trite, but it cannot be repeated too often, that a complete correlation of the history with the patient's localization of the source of his pain, the distribution of the telalgia, the anatomical type and the posture, the general physical examination, the distribution of the ligamentous tenderness, the various manipulative tests for latent muscular spasm or contracture, the measurement of the extremities, the neurologi-

* In the first article of this series we stated that the average number of tender points in all cases was 2.7 per case.

** From the work already done with this test it seems likely that its continued use will shed new light on the exact mechanism of scoliosis. We are collecting additional data in the hope that from them we may discover the laws that govern the complete sequence,—position or motion of a joint, increase or decrease in the tension of individual ligaments, distribution of telalgia, stimulation of muscles, reflex action of muscles, segmental or inclinatory motion [2], scoliosis.

cal examination, the roentgenographic examination, and the laboratory examination is absolutely necessary in every case. We say this, because we have found the special examination described in this article to be so reliable that it tempts one to take short-cuts to diagnosis. There were twelve cases (2.0 per cent.) in this series in which the final diagnosis was made only by the therapeutic test. In two cases that showed the single transitional pattern, we went so far as to stabilize the sacro-iliac joints and, later, the sacrolumbar joint, before the final diagnosis was recorded. Despite the fact that new and accurate methods of diagnosis continually are being added to the surgeon's armamentarium, the problem of the "low-back case" never is an easy one, and there is no substitute for a thorough examination.

SUMMARY

The author has divided sacrarthrogenetic scoliosis into sixteen types and has presented a simple method by which the characteristic patterns may be recognized and recorded. Seven diagnostic rules, the accuracy of which exceeds 90.0 per cent. in the series studied, have been formulated for the interpretation of these patterns. The sixteen types of sacrarthrogenetic scoliosis have been illustrated in the form of a table, so that the etiological significance of each pattern may be determined at a glance.

CONCLUSIONS

Sacrarthrogenetic telalgia regularly is accompanied by scoliosis. In the complete examination of any case in which sacrarthrogenetic telalgia is the presenting symptom, the associated scoliosis usually is the most valuable single sign. The pattern of the scoliosis clearly differentiates sacro-iliac slips from sacro-iliac strains, sprains, or arthritis and, in three cases out of four, affords a positive differential diagnosis between sacro-iliac and sacrolumbar disturbances.

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ANALYSIS OF RESULTS OF EARLY TREATMENT OF CONGENITAL DISLOCATION OF THE HIP BY MANIPULATION AND OSTEOCLASIS FOR ANTERIOR DISTORTION *

BY ARTHUR KRIDA, M.D., PAUL C. COLONNA, M.D., AND FRANCIS J. CARR, JR., M.D., NEW YORK, N. Y.

Congenital dislocation of the hip is a major crippling affection which until fifty years ago was considered to be neither curable nor subject to reasonable amelioration.[2]

In any treatment of congenital dislocation of the hip the objective should be defined. If the objective be palliation—that is, making a good job of a poor business—it should be so specified. If, on the other hand, the objective be a substantial cure with a hip joint which is approximately or completely functionally and anatomically satisfactory, a discussion of results of treatment should confine itself to that objective.

In this study we are concerned with the curability of congenital dislocation of the hip in the above-mentioned sense.

The investigation is based upon a system of treatment devised by the senior author[3, 4] in 1924, while he was an assistant surgeon on the Service of Dr. Royal Whitman at the Hospital for the Ruptured and Crippled. The investigation embraces the patients up to three years of age who were brought to the Hospital for the Ruptured and Crippled on that Service from 1925 to 1931. It also includes the subsequent experience of the associate authors in the independent treatment and follow-up of cases up to 1935, and cases occurring on the senior author's Service at Bellevue Hospital.

A joint dislocation is curable in direct proportion to the time which elapses between its recognition and its treatment. In traumatic dislocation the time element is of the greatest importance, since neglected dislocations are notoriously difficult to reduce by reason of scar-tissue formation.

In the congenitally dislocated hip, the sequence of events is considerably "slowed up". The event of dislocation is by no means dramatic, as in a traumatic dislocation, nor are its implications so apparent. Nevertheless, from a surgical standpoint, essentially similar limiting factors which determine an end result are inherent in both types of dislocation.

The factors which hinder delayed reduction in traumatic dislocations are scar tissue and adaptive muscular contracture. In a gradual type of dislocation, such as congenital dislocation of the hip, scar tissue plays a relatively unimportant part, but muscular and ligamentous changes, and most particularly secondary changes in the architecture of bones, play a most important rôle.

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 19, 1936.

FIG. 1

R. F., aged eighteen months. Bilateral congenital dislocation of the hip. Roentgenogram, taken on November 22, 1927, and made in the usual neutral position of the limb, shows apparent shortening of the neck.

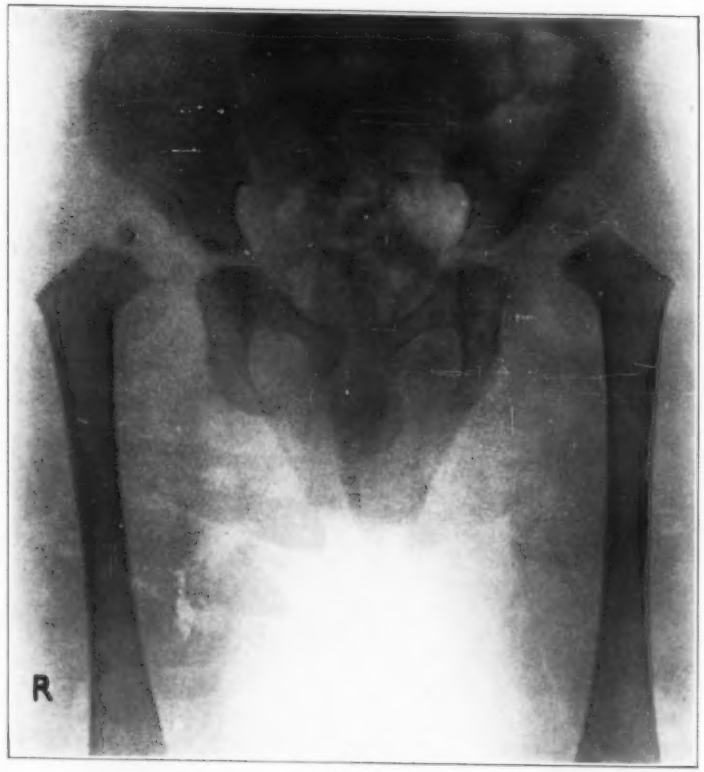

FIG. 2

R. F., November 22, 1927. This roentgenogram was made with both lower extremities in internal rotation. An adequate neck of the femur is displayed, which, in comparison with Fig. 1, indicates that anterior distortion exists.

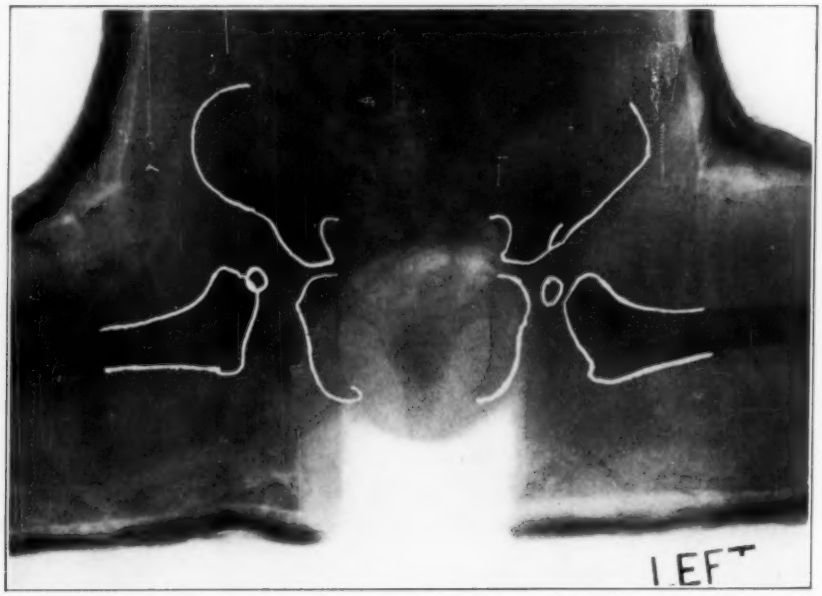

FIG. 3

R. F., December 19, 1927. Roentgenogram (outlined) showing reduction of both hips.

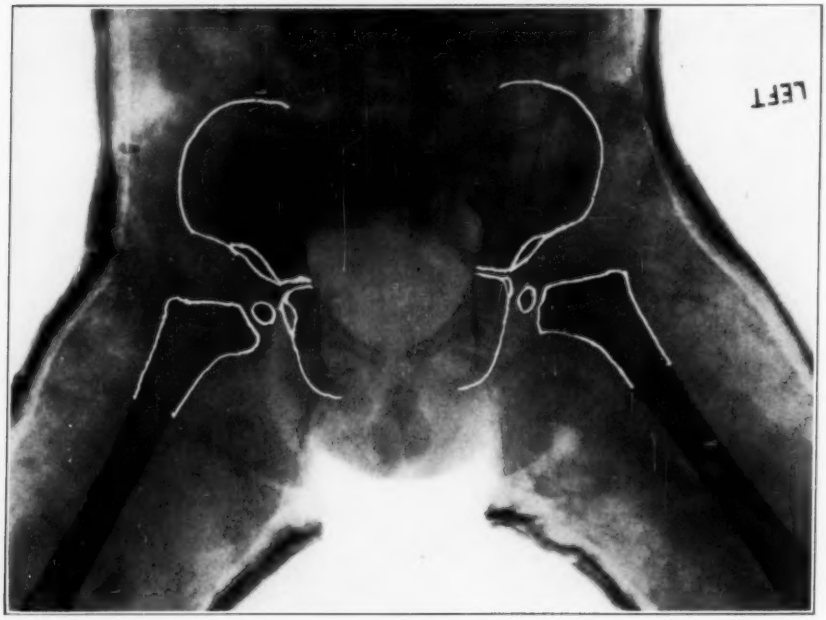

FIG. 4

R. F., January 17, 1928. Roentgenogram (outlined) showing the reduction converted into a "definitive" position. Both lower extremities are in marked internal rotation.

The soft-tissue alterations and adaptations have been extensively described by many writers, and will not be discussed here.

The particular architectural osseous secondary change in this connection is the rebuilding which the upper end of the femur undergoes during the period in which the dislocated hip is submitted to the test of function. It consists in an anterior twist of the upper end of that bone to a variable degree, but frequently up to an angle of 90 degrees. This developmental deformity of the femur impairs the stability of the hip, since it favors redislocation by the route taken in the original dislocation,—namely, anterolaterally. Clinically this distortion is recognizable by palpation and by roentgenograms.

The dislocated hip in the roentgenogram shows little or no neck of the femur. If the femur be rotated inwardly, an adequate neck is displayed.

The technique of treatment described by the senior author evaluates this architectural deformity, anticipates its consequences, and embodies its correction in the routine of the treatment of the dislocation.

The correction of the anterior twist of the femur is accomplished by

FIG. 5

R. F., April 2, 1928. The structural anterior distortion of the femora has been corrected by manual osteoclasis. The lower extremities are now in the neutral position without change in the relationship of the structures of the hip joint.

FIG. 6

R. F., June 28, 1928. The fixation treatment has been terminated and both hips are in place.

manual fracture of the femur in the mid-period of the plaster-of-Paris fixation. It is done in the lower end of the femur; it is easy to perform; and it is entirely innocuous as compared with an open osteotomy.

The dislocation in the age group upon which this study is based is nearly always easily reducible, and with less trauma to tissues than that entailed in an open reduction. Meticulous plaster-of-Paris technique assures retention. The importance of early recognition and adequate treatment has been further stressed by Colonna. Inherent instability may be demonstrable during the manipulative procedure, but redislocation does not occur while the patient is in the plaster-of-Paris dressing. The average treatment period is somewhat less than six months. In those cases in which redislocation occurred, the prognostication of the event was possible at the time of the manipulative reduction or within a few weeks after the removal of dressings.

Of the sixty-six patients comprising this series, fourteen were males and fifty-two were females. All were under three years of age. There were forty-three unilateral cases and twenty-three bilateral cases, making a total of eighty-nine hips.

In two of the bilateral cases there were associated deformities. One case presented spina bifida and club feet; the other, a spastic paraplegia. In each case the dislocation of the hip was cured.

In nineteen of the eighty-nine hips the following complications were encountered: changes allied with Calvé-Legg-Perthes disease in nine cases, or 10 per cent.; coxa vara in two cases, or 2 per cent.; and shallow acetabulum in eight cases, or 9 per cent.

Osteoclasis for correction of anterior distortion was performed on seventy-seven hips, or 86 per cent.

The minimum period of observation was one year; the maximum period, ten years; and the average period, three and two-tenths years.

Of the unilateral cases, good results were obtained in 75 per cent.,

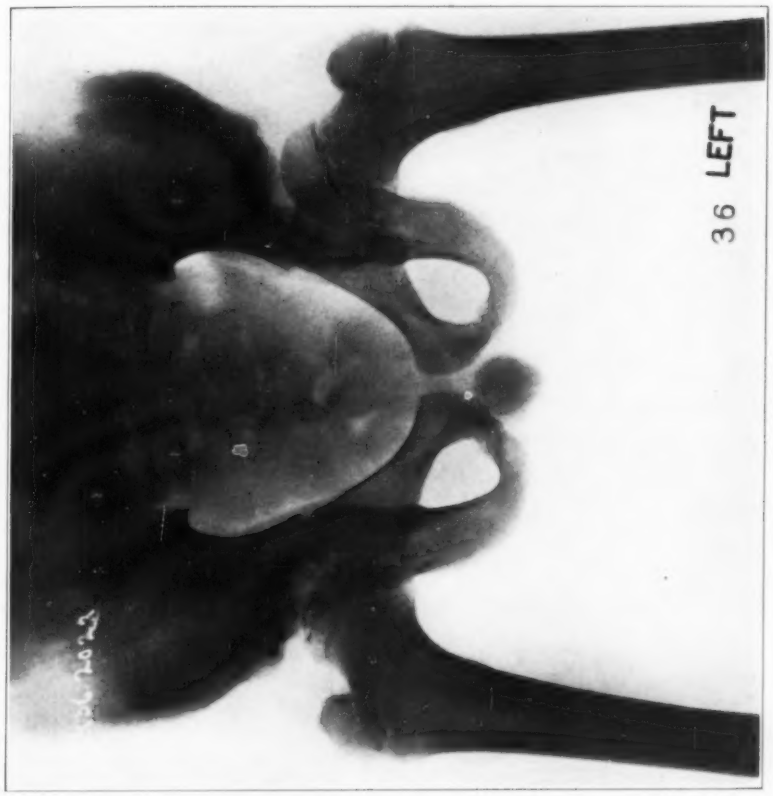

FIG. 8

R. F., April 18, 1936, eight years after completion of treatment.

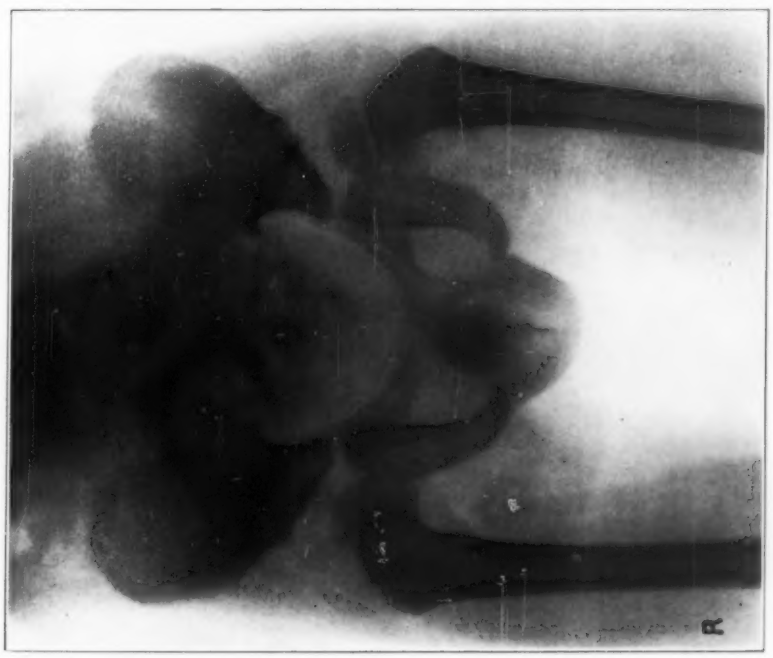

FIG. 7

R. F., February 18, 1930.

fair in 19 per cent., and poor in 6 per cent. The results secured in the bilateral cases were as follows: good in 65 per cent., fair in 17 per cent., and poor in 18 per cent.

A good result indicates a substantial cure with a hip joint which is approximately or completely functionally and anatomically satisfactory. A fair result signifies a reasonably satisfactory hip joint as far as function is concerned, with anatomical or pathological deviations of moderate degree, as demonstrated by the roentgenogram, which might ultimately impair the usefulness of the joint. A poor result denotes an imminent or accomplished redislocation. All bilateral cases in which one joint redislocated are included in this group, since from the patient's standpoint the result is a failure.

SUMMARY

Congenital dislocation of the hip is in our experience a curable affection in direct proportion to its early recognition and the institution of adequate treatment. Potential curability is considered by the authors to terminate at the age of three years.

FIG. 9

N. S., aged two years. Congenital dislocation of the left hip. Roentgenogram taken on April 29, 1936, five years after cessation of treatment.

FIG. 10

A. S., aged two years. Congenital dislocation of the left hip. Roentgenogram taken on April 25, 1936, seven years after cessation of treatment.

FIG. 11

C. G., aged two years. Congenital dislocation of the left hip. Roentgenogram taken on April 27, 1936, ten years after cessation of treatment.

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REVIEW OF 100 CASES OF SCOLIOSIS TREATED BY SPINE FUSION

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During the author's fellowship at the Hospital for the Ruptured and Crippled in New York it was his privilege to review some 500 cases of scoliosis. The investigations were conducted and the conclusions were reached independently.

Of these 500 cases of scoliosis treated by spine fusion, 100 were chosen on the following basis:

1. Patients were able to return for follow-up history and examination;
2. Roentgenograms before and subsequent to operation were available;
3. Patients' own statements concerning the state of their health before and after spine fusion were accessible;
4. All patients were subjected to a test for vital capacity.

Clinically, the end results sometimes appear more favorable than they really are. This review is presented from a laboratory point of view and the writer has tried in no way to interfere with the true statistics.

Of the 100 patients, thirty-three were males and sixty-seven were females. The age incidence was thirteen years, and the duration of the deformity was five years.

The average extent of the operation was ten vertebrae. A two-stage operation was performed in nine cases. The graft broke or became ab-

TABLE I

ANALYSIS OF 100 CASES OF SCOLIOSIS WITH REFERENCE TO TYPE OF SCOLIOSIS IN RELATION TO ETIOLOGICAL FACTOR

Anatomical Types	Etiological Factors					
Curve	Idiopathy (*Cases*)	Polio-myelitis (*Cases*)	Epiphy-sitis (*Cases*)	Congenital Deformity (*Cases*)	Rickets (*Cases*)	Total No. of Cases
Dorsal kyphos	2		3		2	7
Right dorsal	12	6				18
Left dorsal	6	6		1		13
Right dorsal, left lumbar	20	10	1			31
Left dorsal, right lumbar	19	8				27
Right lumbar	1					1
Left lumbar	3					3
Total	63	30	4	1	2	100

TABLE II

TREATMENT

Method of Correction	Preoperative Treatment *		Postoperative Treatment **	
	Cases	Time	Cases	Time
Convex frame and jackets	66	5 weeks	79	3 months
Plaster-of-Paris jackets	16	2 years	11	5 months
Turnbuckle jackets	2	6 weeks		
Braces only	16	6 months	10	2 years
Total	100		100	

* Average preoperative corrective treatment: 3 months.

** Average postoperative corrective treatment: 6 months.

TABLE III

TYPE OF OPERATION AND RESULTS

Type of Operation	No. of Cases	Fused	Not Fused
Hibbs technique	46	24	22
Hibbs, with tibial graft	23	20	3
Hibbs, with rib graft	19	18	1
Hibbs, with beef-bone graft	12	4	8
Total	100	66	34

TABLE IV

CLINICAL END RESULTS IN 100 CASES

Clinical Aspects	Excellent	Improved	Not Improved
General health	30	53	17
Contour	13	26	61
Posture	23	27	50
Vital capacity	27	51	22

sorbed in five cases. The mortality rate was 1 per cent., and the cause of death was a heat stroke.

Pain was present postoperatively in seventeen cases. There was an average increase of 14 degrees in the angle of deformity in twenty-three cases.

There are a great many figures to present in this type of paper and the author has attempted to simplify and analyze them by the accompanying tables.

CONCLUSIONS

1. Scoliosis is more common in females than in males in the ratio of two to one.

2. The average age of patients when they present themselves for examination is twelve years, and the average age at the time of operation is fourteen years.

3. Idiopathic cases of scoliosis are twice as frequent as poliomyelitic cases.

4. Fusion does not always relieve pain.

5. Fusion is successful, in so far as solid bony union is concerned, in 66 per cent. of the cases.

6. The general health of the patient is improved in about 83 per cent. of the cases and the general contour in only 50 per cent. of the cases.

7. The use of an autogenous bone graft assures a more solid fusion than does the Hibbs technique alone.

8. A two-stage operation is indicated if the curve extends through more than eight vertebral bodies.

9. The frame treatment is safer, interferes less with the vital capacity, and permits the patient to be more comfortable than any other form of corrective apparatus.

10. In spite of fusion, 23 per cent. of the cases showed an average increase of 14 degrees in the angle of deformity.

11. All patients subjected to spine fusion should wear some type of support for at least eighteen months after the operation.

12. Cases of idiopathic scoliosis respond more favorably to treatment than any other type.

13. Kyphos deformities are corrected little, if any, by operation.

14. The operation should not be performed before ten years of age if solid fusion is to be expected.

15. The use of beef-bone grafts is contra-indicated.

16. In cases of scoliosis in which poliomyelitis is the etiological factor, there is a greater frequency in postoperative deformity, and a greater degree, than in any other type.

17. The mortality rate as the result of the fusion operation is practically negligible.

SUMMARY

In spite of any discouraging conclusions, it is the author's belief that the spine-fusion operation has a very definite place in the armamentarium of the orthopaedic surgeon. The procedure definitely assures more rapid correction of the deformity and offers the patient the hope of eventually discarding all apparatus with safety.

The author wishes to express his appreciation to Dr. Armitage Whitman for his help and constructive criticism. He is greatly indebted also to Mr. J. D. Flick, Superintendent of the Hospital for the Ruptured and Crippled, for permitting him the use of the x-ray laboratory to obtain follow-up roentgenograms, and to Dr. K. G. Hansson, whose department made possible the tests for vital capacity.

FRACTURE-DISLOCATION OF THE ELBOW WITH ULNAR-NERVE INVOLVEMENT

Reduction by Tension on the Superficial Flexor Group of Muscles *

BY ADOLPH A. SCHMIER, M.D., DETROIT, MICHIGAN

This case of fracture-dislocation of the elbow is presented because of several interesting features which it possesses,—namely, the relative infrequency with which this type of injury is met, the method of reduction employed, and the favorable result obtained, which may not however be the end result.

W. C., a boy, sixteen years of age, injured his right elbow on May 30, 1932. He fell off a chinning bar, landing on his right hand with the elbow extended. At a near-by hospital a dislocation of the elbow was supposedly reduced and immobilized in flexion. Because of persistence of pain and increased swelling at the elbow, a roentgenogram was taken the following morning. Through the courtesy of Dr. S. Millman the author had the privilege of examining and treating this patient. In addition to pain and swelling of the elbow, the patient complained of numbness in the hand. Examination revealed complete anaesthesia of the little finger, of the ulnar half of the ring finger, and of the ulnar aspect of the hand. Flexion of the terminal phalanges of these fingers was possible. Roentgenograms of the right elbow (Fig. 1), compared with those of the normal left

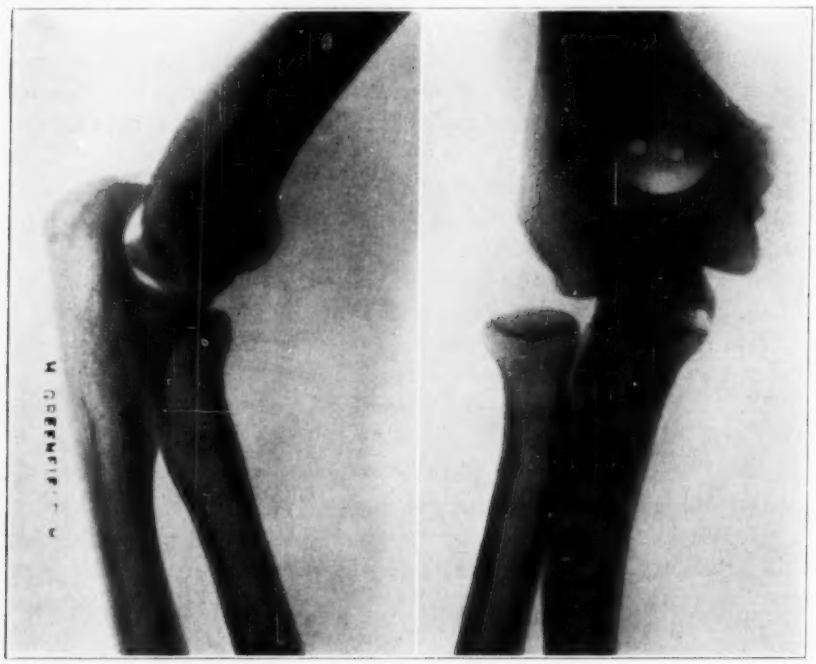

FIG. 1

Lateral, posterior, and downward dislocation at elbow with intra-articular interposition of epitrochlea.

* Presented at the Orthopaedic Departmental Conference of the Hospital for Joint Diseases, New York City, February 18, 1936.

elbow (Fig. 2), disclosed a fracture or separation of the epitrochlear epiphysis with its displacement into the elbow joint; also a lateral, posterior, and downward dislocation of the radius and ulna *en masse*.

Since the superficial flexor muscles of the forearm, originating from the epitrochlea by a common tendon, pronate the forearm, flex the wrist and fingers, and aid in flexing the elbow, it was felt that if tension could be applied to these muscles, the interposed epitrochlea might be dislodged from the elbow joint by the muscle pull upon it. Accordingly, under general anaesthesia the forearm was supinated, the wrist, fingers, and elbow were extended, and the forearm was slightly abducted, so as to increase the gap between the trochlea and the ulna. No more abduction was employed than is ordinarily used in the open operation. In reporting similar cases with ulnar-nerve involvement in which he operated, Cotton described a fascial or fibrous band which follows the excursion of the epitrochlea into the elbow joint, thus constricting the ulnar nerve beneath it. The author felt that if the bony fragment could be dislodged from the elbow joint and replaced to approximately its normal position by the manoeuver described, the constricting force of the fibrous band would be removed and the ulnar nerve might resume its normal function. It is important to note that hardly any force was employed. The first two attempts produced a slight "click", as though the fragment were moving between the humerus and the ulna. On the third attempt a loud report was heard. Under the fluoroscope the fragment could not be seen in the joint, and roentgenographic examination (Fig. 3) revealed the fragment displaced out of the joint and the dislocation reduced. The epitrochlea was not in close apposition with the internal condyle and it was also displaced somewhat anteriorly. Because of the marked swelling at the elbow and obliteration of the radial pulse when flexion was attempted, the arm was immobilized in considerable extension as noted in the roentgenogram. It was felt that when the swelling subsided more acute flexion at the elbow would further reduce the epitrochlea. This was

FIG. 2
Normal left elbow.

possible one week later, at which time a felt pressure pad was also applied over the internal epicondyle.

On June 30, one month after reduction, roentgenograms (Fig. 4) revealed closer approximation of the epitrochlea. However, a periosteal reaction was noted on the lateral aspect of the lower end of the humerus. This was undoubtedly due to injury of the periosteum either at the time of the accident, or during the supposed reduction, or at the time of the actual reduction. Similar periosteal reaction is described in cases treated by open reduction.

On July 25, about two months after the injury, no change was noted in the ulnar-nerve involvement. The anaesthesia previously described was still present. Action of the flexor digitorum profundus, interossei, and flexor carpi ulnaris was present but weak. The skin over the hypothenar eminence could not be wrinkled (palmaris brevis). An open operation was therefore performed. The nerve was found behind the internal epicondyle and was flattened and bound down by dense adhesions. The nerve was freed and on palpation it was found to be soft throughout, except in two spots where slight firmness was felt. It was transposed to the anterior aspect of the elbow. The epitrochlea was palpated and only a faint trace of false motion was noted, not enough to warrant either fixation or removal. The following day the patient moved the little finger much better and stated: "I know where I'm moving it." Within one week the strength of all the involved muscles was greatly enhanced. The skin over the hypothenar eminence could even be wrinkled.

On November 1, the patient complained of pain at the outer aspect of the elbow, and tenderness was present over the outer condyle of the humerus. Roentgenograms (Fig. 5) revealed an increase in the periosteal bone formation running from the external humeral condyle down toward the head of the radius. There was no union clinically to the

FIG. 3

Fragment displaced out of joint and dislocation reduced. Epitrochlea still somewhat lateral and anterior.

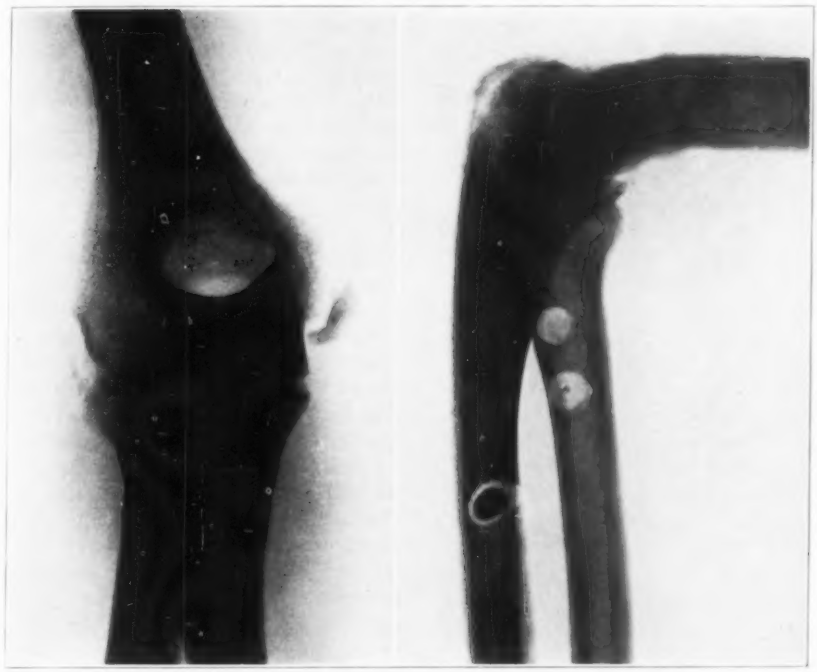

FIG. 4

One month after reduction. Closer approximation of epitrochlea. Note periosteal reaction at lateral humeral condyle.

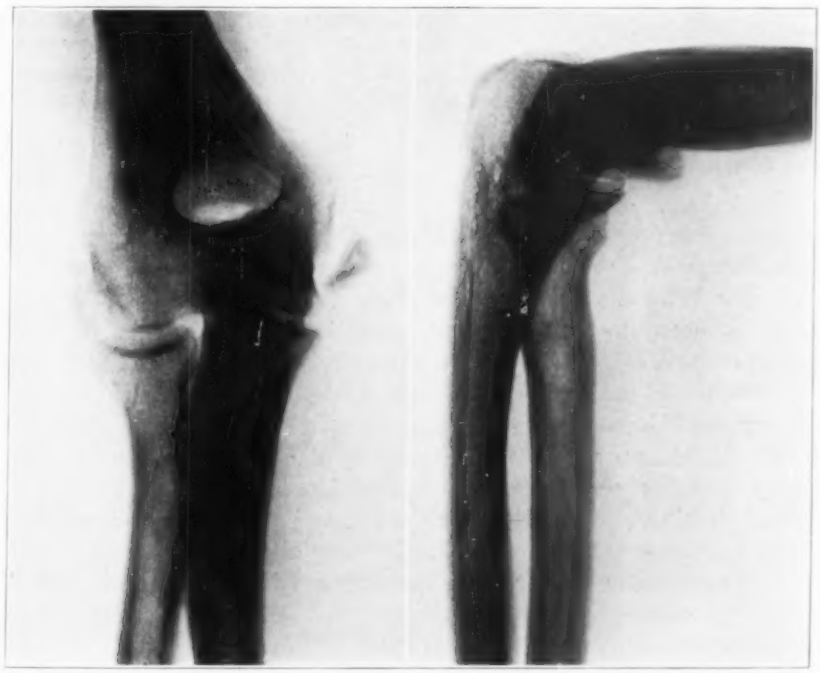

FIG. 5

Five months after reduction. Increase in pericondylar bone formation.

radius, since pronation and supination were normal. On November 8, fifteen weeks after operation, sensation returned to the hand in the form of hyperaesthesia. On January 12, 1933, twenty-four weeks after operation, hyperaesthesia was present in the little finger and in the ulnar half of the ring finger. Sensation over the ulnar aspect of the hand was now normal. Flexion of the elbow was possible to within 5 degrees of normal, and extension to 145 degrees. Pronation and supination were normal.

FIG. 6

Almost four years after reduction. Progressive bony proliferation from lateral humeral condyle. No union clinically with head of radius. Beginning bone production between epitrochlea and humerus (seen better in original roentgenogram).

On November 27, 1935, the patient was seen for follow-up examination. He had no pain in the elbow, forearm, or hand. He used his arm regularly at his work of packing ice, and the cold did not affect his hand or fingers. Flexion of the elbow was normal, and extension was possible to 165 degrees. Pronation and supination were normal. Spread and adduction of the fingers were slightly less powerful than in the normal hand, and the skin over the hypothenar eminence could be strongly wrinkled. Sensation over the ulnar aspect of the hand and over the ring and small fingers was normal. A roentgenogram (Fig. 6), taken February 5, 1936, revealed progressive bony proliferation from the outer condyle of the humerus, running toward the head of the radius. Clinically there was no union with the radius. Bony proliferation between the internal epicondyle and the humerus was also revealed.

In reviewing the literature of fracture-dislocation of the elbow with interposition of the epitrochlea, the author has found no mention of a method of closed reduction similar to that which he has described. Cotton describes the method of Albert as follows: "Flex the arm to a right angle and separate the joint surfaces by pulling down on the upper part of the bent forearm; then swing the forearm inward." Fèvre and Roudaïtis advise abduction of the forearm in extension and supination, longitudinal traction in the axis of the arm, and flexion of the forearm with or without translatory movement to the inside. Zadek reports closed reduction by increasing the carrying angle and by then applying traction and digital pressure on the head of the radius. In all the other cases that the author has reviewed reduction was obtained either by these methods or by open operation.

In cases without ulnar-nerve involvement, the writer feels that the method of reduction which he has described is logical, since it is based upon anatomical and kinesiological data. Whenever possible, immobilization should be obtained with the forearm flexed and pronated, so as to

release any tension on the flexor muscles attached to the epitrochlea. Where ulnar-nerve involvement is present—and this is usually due to constriction by a fibrous tissue band attached to the displaced epicondyle rather than to a tear, as demonstrated by Cotton—the author believes that the closed reduction described may release the constriction on the nerve. Since the manoeuver is not a forcible one, it is probable that no further damage could be done to the nerve. If, after a reasonable length of time following reduction, there is no return of ulnar-nerve function, the nerve should be explored.

In the case described the actual significance of the bony proliferation from the external humeral condyle as regards elbow motion cannot be definitely stated. Despite the fact that repeated roentgenograms revealed a progressive ossification, it had not interfered with elbow motion in almost four years.

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END RESULTS OF FRACTURES OF THE PROXIMAL HUMERAL EPIPHYSIS

BY ALEXANDER P. AITKEN, M.D., BOSTON, MASSACHUSETTS

In previous publications [1, 2, 3] the author has reported on the end results of fractures of the distal radial and tibial epiphyses. From this work the following facts have been pointed out:

1. The various epiphyses must be considered individually as to end results.

2. Each epiphysis is subject to at least three types of fracture, the end results of which vary considerably.

3. Fractures through or crushing of the cartilage plate are the prime causes of deformity. Damage of this nature is determined at the time of injury and over it we have no control.

4. Malposition is not a cause of deformity.

5. Anatomical reduction is not necessary, and osteotomy for correction is not only an unnecessary but also a dangerous procedure.

6. Premature ossification and retardation of growth are common sequelae, but in the great majority of cases they are of little clinical significance.

In this study of the proximal humeral epiphysis, the same facts hold true.

This series is composed of eleven cases which have been followed for from one to five years from the date of injury. All of these injuries occurred in male patients. Eight cases occurred between the ages of thirteen and fifteen. Two patients were eighteen and nineteen years of age. The remaining case was that of a boy six years of age. In six patients the epiphysis was displaced medially and forward, and in all but the youngest patient (Fig. 1-A) there was an associated chip fracture of the medial end of the shaft. In five cases the epiphysis was displaced laterally with a fracture of the lateral portion of the shaft. In two cases open reduction was performed and in each case the displaced head was held in place with a three-inch nail.

In all of these cases the fracture was of the first type [3],—*i. e.*, the fracture line ran through the layer of transitional cartilage and newly formed bone, which lies between the cartilage plate and the shaft proper. In no case was there a fracture through the bony epiphysis and the cartilage plate, and no evidence of crushing of the epiphysis could be seen by x-ray. The author believes crushing of the proximal humeral epiphysis to be a rare occurrence. The rarity of such compression injuries is due probably to the great mobility of the humeral head.

In six cases accurate reduction was not obtained despite repeated attempts by manipulation or by traction. (See Figures 1-B and 2-B.) In none of these cases is there any evidence of the displacement at the

FIG. 1-C

One year later. Note complete correction of the displacement and absence of any deformity.

FIG. 1-B

Position on discharge. Note incomplete reduction.

FIG. 1-A

A case of fractured proximal humeral epiphysis in a boy six years of age. Roentgenogram on admission.

FIG. 2-A

A case of fractured proximal humeral epiphysis in a boy eighteen years of age. Roentgenogram on admission.

FIG. 2-B

Position four weeks later on discharge from the hospital. Note incomplete reduction and formation of bone by periosteum between the shaft and the displaced head.

present time. (See Figures 1-C and 2-C.) Correction of displacement occurs here as it does in the other epiphyses which have been described. When the epiphysis is displaced the periosteum on the side of the displacement remains attached to the epiphysis, but is stripped off the shaft. The periosteum then lays down bone in the triangle formed by the shaft, by the displaced head, and by the periosteum itself. The other side of the shaft becomes absorbed. In this manner the shaft is swung over to the displaced epiphysis. For the first few months there is a bowing of the shaft toward the epiphysis. This bowing is corrected within a few months as the patient uses his arm. Only rarely can this bowing be seen clinically and it is of no importance as regards function. As was found in the previous studies, malposition does not persist and is not a cause of deformity.

FIG. 2-C

Upper humerus three years later. Note correction of the displacement. Shortening amounts to a quarter of an inch.

Premature ossification occurs frequently. In the youngest patient (six years of age) ossification has not yet begun. In one of the two cases in which operations were performed, ossification is complete in both epiphyses. In the other case it is complete in the nailed epiphysis, but has not yet begun in the uninjured one. The author believes that the driving of a nail through the cartilage plate for fixation caused the prompt ossification in this case (one year from the date of injury). In the remaining eight cases ossification has begun in both epiphyses, but in each case it is more advanced on the injured side.

Shortening, due to retardation of growth, was greater in this series than was noticed in the studies of the radial and tibial epiphyses. In four cases there was no shortening; this group includes both of the cases in which operations were performed. This lack of shortening in the operated case in which fusion occurred bilaterally is due probably to the fact

that both epiphyses were about to fuse at the time of the injury. This patient was fifteen years of age at the time of injury, which occurred two and one-half years ago. In the other operated case there was no shortening; the injured epiphysis is ossified, while ossification has not yet begun in the opposite epiphysis. This boy was injured one year ago and is now sixteen years of age. If ossification occurs in the opposite epiphysis within a few months, no shortening will develop. However, further growth can occur in this epiphysis for another two years. It must be borne in mind that both of these patients are in the upper age group and both have probably reached their maximum growth. The author feels certain, however, that open reduction and fixation in younger individuals is a dangerous procedure, due to the possibility of arrest of growth caused by damage to the cartilage at the time of operation.

Shortening of from one-quarter of an inch to one-half an inch occurred in three cases, of three-fourths of an inch to one inch in three cases, and of one and one-quarter inches in one case. In this latter case the original displacement was very slight, and no attempt at correction was made. In none of these cases was the patient aware of the fact that one arm was shorter than the other. Shortening, then, is of little clinical significance in the proximal humeral epiphysis even if the loss in growth amounts to a full inch. However, if the arm were made up of two bones (as in the forearm or leg) or if it were a case of a weight-bearing epiphysis (as is the lower femoral epiphysis) then this shortening would be of definite clinical significance. The fact that shortening is more marked in the proximal humeral epiphysis than in the lower radial or tibial epiphysis is probably due to the fact that the former is more actively growing, and also to the fact that it is larger and more irregularly shaped. A greater force is thus required to displace it, with the consequent greater possibility of damage to the cartilage plate.

From this study it seems that the average age of ossification is between the sixteenth and eighteenth years. It is also to be noted that ossification normally occurs first on the medial side of the epiphysis. That portion of the cartilage plate subjacent to the greater tuberosity normally fuses last, just as that portion of the distal radial epiphysis proximal to the styloid is the last to ossify.

SUMMARY

All of the eleven cases of fracture of the proximal humeral epiphysis presented in this series were torsion fractures occurring between the cartilage plate and the shaft proper (Type-1 fracture[3]). No compression fractures of the epiphysis were seen. This type of epiphyseal injury, which is common in the ankle, the writer believes to be rare in this epiphysis, due to the mobility of the humeral head. In no case is there deformity, although accurate reduction was not obtained in six of the cases. Malposition is, therefore, not a cause of deformity. Premature ossification does occur, as does retardation of growth. Shortening was not only

much more common in this epiphysis than in the distal radial and tibial epiphyses, but was also more marked. The fact that this shortening could not be detected clinically in any case is due to the fact that the arm is non-weight-bearing and consists of but one bone. In general, the end results obtained in all of the cases in this series were good.

CONCLUSIONS

The author wishes to emphasize the fact that malposition is not a cause of deformity. Any malalignment is corrected within a few months. Deformity and shortening are due to damage to the actively growing cartilage plate. This damage is done when the accident takes place, and, when this damage is received, it is not possible with our present knowledge to prevent the inevitable growth disturbances. One can, however, add to the damage already done by attempting to get anatomical position by operative procedures.

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THE EFFECT OF LUMBAR SYMPATHETIC GANGLIONECTOMY ON LONGITUDINAL BONE GROWTH AS DETERMINED BY THE TELEOROENTGENOGRAPHIC METHOD

BY JOHN J. FAHEY, M.D., OXFORD, MISSISSIPPI

From the Department of Surgery, University of Chicago

Stimulation of longitudinal bone growth has recently been added to the list of effects that have been claimed for lumbar sympathetic ganglionectomy. In 1930 Harris first reported stimulation of longitudinal bone growth in man following lumbar sympathectomy in a case of limb-shortening resulting from anterior poliomyelitis. The theoretical justification of the procedure was based on the observation that lesions associated with increased vascularity sometimes produce an overgrowth of an involved limb. In a recent report by the same author lumbar sympathetic ganglionectomy was claimed to have accelerated longitudinal bone growth in twenty-one of forty-six cases in which the operation had been performed for shortening caused by anterior poliomyelitis. Also four cases of Hirschsprung's disease, in which left lumbar sympathetic ganglionectomy had been performed, showed overgrowth of the ipsilateral leg.

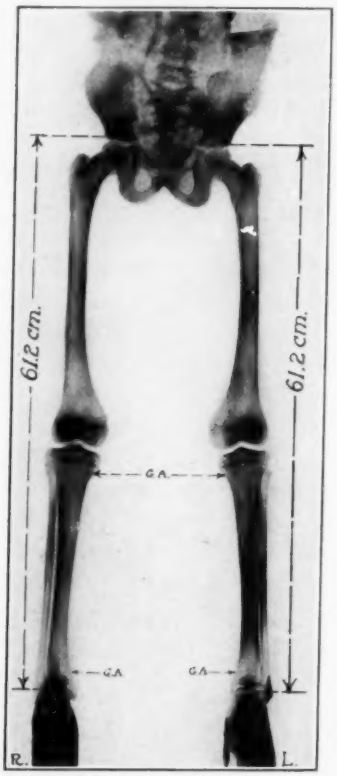

FIG. 1-A

Case 1. Teleoroentgenographic measurements of the lower extremities made nineteen months after left lumbar sympathetic ganglionectomy for Hirschsprung's disease. Measurements show no discrepancy in limb length. *G.A.*: growth-arrest lines in the tibial metaphyses.

Experimenters have been unable to produce overgrowth of an extremity by lumbar sympathetic ganglionectomy. Cannon and his co-workers observed no increased longitudinal growth of the extremity in kittens in which the entire sympathetic chain had been removed on one side. Bacq obtained similar results in young albino rats. Bisgard also failed to find increased longitudinal growth in a half-grown monkey with symmetrical paralysis of the lower extremity due to poliomyelitis. This same author found no increase in longitudinal growth following lumbar sympathectomy in four normal young goats. Harris and McDonald performed unilateral lumbar sympathectomy upon ten kittens, twelve puppies, and eight lambs, and reported no

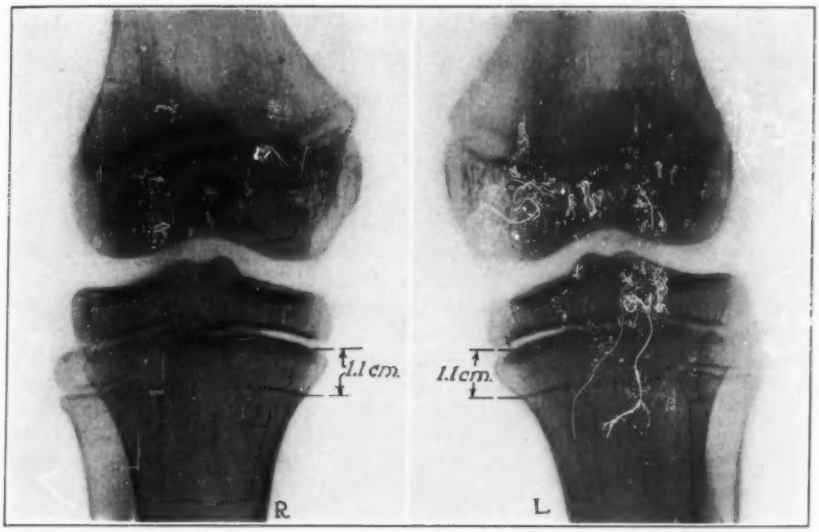

FIG. 1-B

Case 1. Roentgenograms showing growth-arrest lines present in the upper tibial metaphyses. These are equidistant from the epiphyseal line.

acceleration of longitudinal growth of the extremity on the sympathectomized side.

The evidence for increased growth following lumbar sympathetic ganglionectomy is based then upon reported limb overgrowth following the use of the operation in four cases of Hirschsprung's disease and upon reported diminution of discrepancy in limb length following the use of the operation in cases of residual paralysis due to poliomyelitis.

During the past four years three unilateral lumbar sympathetic ganglionectomies have been performed upon children in the University of Chicago Clinics. One of these was done for the purpose of remedying vascular disturbances in a case of congenital abnormality of the leg with shortening; this case, therefore, is not suitable for testing the effect of the operation on longitudinal bone growth, because contralateral epiphyseal-diaphyseal fusion had been performed for the purpose of equalizing limb length. In the other two

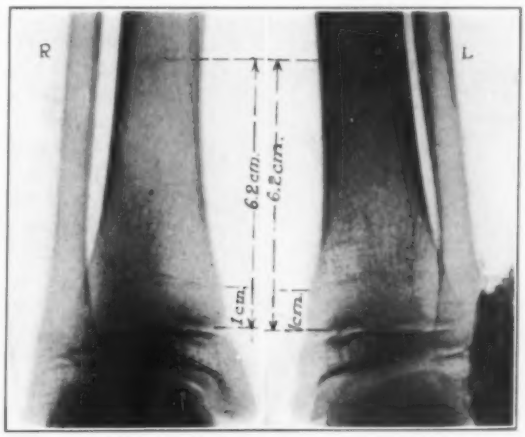

FIG. 1-C

Case 1. Roentgenograms showing growth-arrest lines in the lower ends of both tibiae. Lines are similarly equidistant from the distal tibial cartilage plate.

cases left lumbar sympathetic ganglionectomy was done for Hirschsprung's disease, and these cases are suitable for determining any possible stimulation of longitudinal bone growth.

REPORT OF CASES

CASE 1. B. N., a male, aged ten years, was seen because of constipation and enlargement of the abdomen. He had had no spontaneous bowel movement since three years of age. Enemas were usually necessary every three or four days. A diagnosis of Hirschsprung's disease was made, and, on June 26, 1934, a left lumbar sympathetic ganglionectomy was performed by Dr. C. B. Huggins. One inch of the presacral nerve, the third and fourth left lumbar ganglia, and the left lumbar sympathetic chain were removed up to a point near the left renal artery.

The result in this case was spectacular. The markedly distended abdomen, which was noted prior to operation, is no longer present. The patient is having a spontaneous bowel movement every three to four days. Teleoroentgenographic measurements of the lower extremities, made nineteen months following operation (Fig. 1-A), show no discrepancy in the length of the lower extremities. Growth-arrest lines are present in the upper and lower tibial metaphyses on both sides. Measurements showed them to be equidistant from the epiphyseal lines (Figs. 1-B and 1-C). On palpation, there is a definite increase in warmth of the left foot and leg as compared to that of the right. This difference is particularly noticeable in the distal portion of the extremity. Temperature readings, made by means of the thermocouple at various levels of the lower extremities twenty months following operation, are shown in Table I.

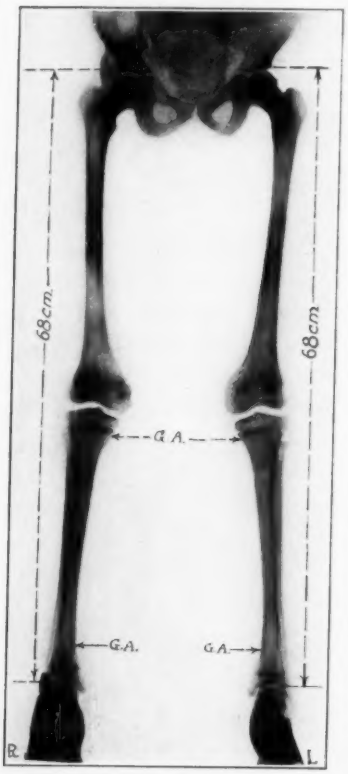

FIG. 2-A

Case 2. Teleoroentgenographic measurements of the lower extremities ten months after left lumbar sympathetic ganglionectomy. The extremities are of equal length. *G.A.*: growth-arrest lines resulting from the operation.

CASE 2. F. C., a male, aged ten years, was seen at the University of Chicago Clinics with a complaint that he had been constipated all his life. He had noticed a progressive enlargement of the abdomen for a few years prior to his admission. On examination, the abdomen was found to be distended and a tympanic note was present on percussion. A roentgenographic study showed the enlarged colon of Hirschsprung's disease. Left lumbar sympathetic ganglionectomy and presacral neurectomy were performed on March 13, 1935, by Dr. C. B. Huggins.

Following the operation the patient was promptly relieved of distention, and bowel movements became spontaneous and have thus far remained normal. Palpation of the extremities, eleven months after operation, revealed increased warmth of the sympathectomized side. This was corroborated by temperature readings made at various points on the lower extremities by means of the thermocouple (Table I). Teleoroentgenographic measurements (Fig. 2-A) of the lower extremities, made ten months subsequent to operation, revealed no discrepancy in length of the lower extremities. In this case, as in Case 1, retarded

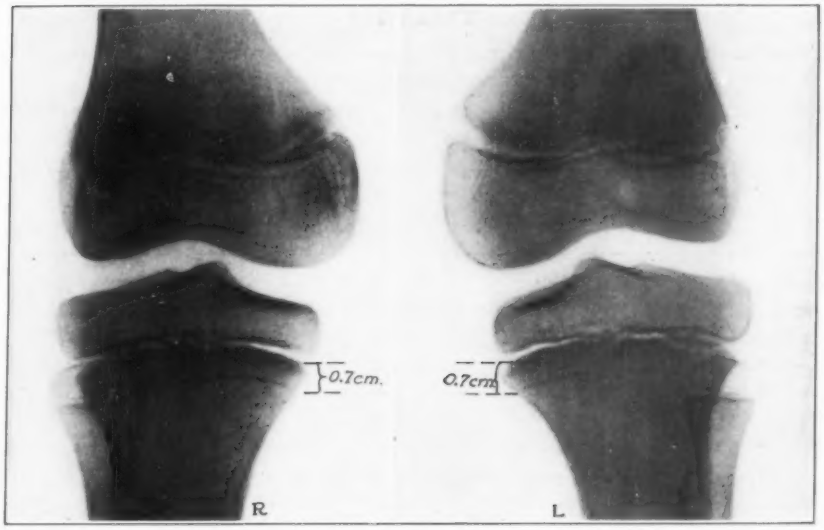

FIG. 2-B

Case 2. Roentgenograms of knee region showing growth-arrest lines in the upper tibial metaphyses. Teleoroentgenographic measurements are shown in the margins.

growth lines, present in the upper and lower tibial metaphyses as a result of the operation, are equidistant from the epiphyseal lines (Figs. 2-B and 2-C), showing that longitudinal bone growth on the ipsilateral side had not been stimulated by the operation.

DISCUSSION

Increased warmth of the extremity occurs following lumbar sympathetic ganglionectomy as a result of vasodilatation. The influence of this increased vasodilatation, with its associated increased warmth of the limb, on longitudinal growth is doubtful because it is not comparable to overgrowth produced by pathological processes, for in these conditions, as in osteomyelitis, passive hyperaemia is present. Experimentally this is substantiated by increased osteogenesis found in passive hyperaemia by Pearse and Morton and by McMaster and Roome, whereas these same authors and Key and Moore found no increase in the rate of fracture healing in the sympathectomized extremities of dogs.

The usual clinical measurement is not accurate enough to detect small changes in limb length. Roentgenograms taken in the ordinary manner are likewise unsatisfactory. The measurements of the two patients whose cases are reported here were obtained by means of the

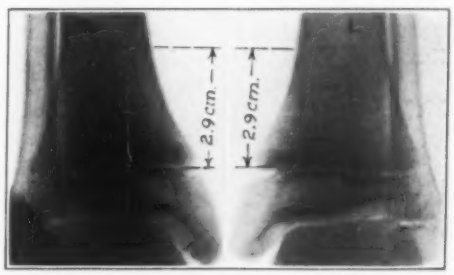

FIG. 2-C

Case 2. Teleoroentgenograms showing no discrepancy in distance of growth-arrest lines from the epiphyseal lines in the lower tibiae.

TABLE I

TEMPERATURE READINGS OF LOWER EXTREMITIES FOLLOWING LEFT LUMBAR SYMPATHETIC GANGLIONECTOMY

	Case 1 *		Case 2 **	
	Right (*Degrees C.*)	Left (*Degrees C.*)	Right (*Degrees C.*)	Left (*Degrees C.*)
Dorsum of first toe....	24.0	27.6	25.6	28.1
Dorsum of foot.....	26.2	29.6	28.0	30.7
Plantar surface of foot	26.8	28.6	26.4	28.6
Anterior border of middle of tibia.....	29.6	30.6	27.4	27.7
Middle thigh.....	30.5	30.5	27.4	27.5

* Twenty months after operation. ** Ten months after operation.

stereoscopic teleoroentgenographic method. Errors due to position of the limb and to distortion are eliminated by this technique. Although in each case there was definite clinical improvement of the Hirschsprung's disease following sympathectomy, as well as increased warmth of the sympathectomized side, no acceleration of longitudinal bone growth occurred on the sympathectomized side.

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STUDY OF THE END RESULTS IN 113 CASES OF SEPTIC HIPS *

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This study of the end results in 113 cases of septic hip lesions treated at the University Clinic was undertaken primarily to determine if possible the answer to the several questions constantly confronting us in treating this group of cases:

1. Does streptococcal infection of the hip joint react differently from staphylococcal infection?
   a. Should arthrotomy be performed in all cases showing clinical evidence of septic hip-joint involvement?
   b. Is the type of organism which produces a septic hip the determining factor in the hip reaction, or is the reaction due to the location of the lesion (1) primarily in synovia or (2) primarily in bone with secondary hip involvement?
   c. Does the age of the patient alter the course of the hip lesion?
2. What are the causes and the results of the several complications so frequently associated with septic hips,—dislocation of the hip, sequestration of the femoral head, epiphysiolysis, disappearance of the head of the femur?
3. What are the end results of treatment by various methods, at various stages of the disease, and when the disease is associated with the various types of complications?

To interpret properly the results of this study, it is essential to recognize that the majority of the reported cases fall into the subacute or chronic phases of the lesion, with relatively few cases of acute septic hips. This report makes a corollary for the excellent study by Slowick [1] of sixty cases, chiefly of acute or of early subacute pyarthrosis of the hip. With very few exceptions, at least four weeks' duration of symptoms in our cases was the minimum on admission, with the average duration running into months.

One hundred and thirteen cases of septic hip-joint lesions have been studied; in eleven the condition was bilateral. There was a slight predominance of males,—sixty-two to fifty-one females. The age incidence ranged from four weeks for the youngest to fifty-three years for the oldest; eighty-five patients were between six and eighteen years of age, and the most common age was fourteen years.

Fourteen of the 113 patients died,—twelve from septicaemia, one

* Read at the Annual Meeting of the American Orthopaedic Association, Milwaukee, Wisconsin, May 20, 1936.

TABLE I

ANALYSIS OF LESIONS IN PATIENTS UNDER SIX YEARS OF AGE (CLASSES 1 AND 2)

Clinical Group	Age Period (*Years*)	No. of Cases	Streptococcus	Staphylococcus	Osteomyelitis: Ilium	Osteomyelitis: Head and Neck	Epiphysiolysis Head Sequestrated	Dislocation	Other Changes	End Results
A	0–2	1		1				1		Good reduction and free motion. Small oblique acetabulum; nucleus of head not present.
	3–5	0								
B	0–2	3	Hemolyticus (2) Non-hemolyticus (1)					Spontaneous (1) Intentional (1)	Capsular distention (2)	Dislocation reduced (2); coxa vara (1); disappearance of nucleus of head (3).
	3–5	6		2	2			Accidental (1)		Dislocation reduced with disappearance of nucleus of head (1); normal hip (1).
			Hemolyticus (4)				1	Spontaneous (1)	Capsular distention (2)	Dislocation reduced with disappearance of nucleus of head (1); died (1); normal hip (1); normal hip motion, head removed, gluteal gait (1).
C	0–2	2*	Organism unknown						Disappearance of head and misshaped neck	Rapid healing; good motion. Coxa vara and gluteal gait.
	3–5	2**		2 (?)		1†		Pathological (2)	Bony ankylosis to ilium (1)	Flail hip after resection of head and neck (1). Bony ankylosis to ilium, good position (1).

* Seen at eight and seventeen years.
** Seen at nine and fifteen years after onset.
† Resection was done because of active bone infection.

from a flare-up of infection following a reconstruction operation, and one from postoperative shock.

For the purpose of this study, the cases were divided into three main groups:

Group A—Twelve Cases

The patients in this group entered the Clinic in the acute, subacute, or early chronic stages, without previous treatment, and were treated *conservatively* except for drainage of presenting soft-tissue abscesses.

Group B—Forty-Two Cases

These patients were in the acute, subacute, or early chronic phases, had not had previous treatment, and were treated *surgically* in our Clinic.

Group C—Fifty-Nine Cases

The majority of the patients in this group were in the chronic phase; a few, who had been treated outside our Clinic, were in the subacute phase. The treatment of these patients in our Clinic was mainly surgical; occasionally conservative measures were employed.

These groups are further subdivided into age periods to differentiate any characteristic reactions in the hip joint at various ages if they so occur.

Class 1: From birth to two years inclusive—six cases.

Class 2: From three to five years—eight cases.

Class 3: From six to eighteen years—the period of rapid growth to fusion of the capitate epiphysis—eighty-five cases.

Class 4: Nineteen years and over—adult changes—fourteen cases.

STUDY OF THE AGE PERIODS

Table I illustrates the type of lesion produced by the streptococcus and staphylococcus in patients under six years of age.

In each of the six cases in Class 1 (infant group) there was a good range of motion, but a gluteal gait will undoubtedly be present if the results in the older cases in Group C are any criterion. Disappearance or failure of development of the bony nucleus of the capitate epiphysis with later return or partial reappearance and maldevelopment of the head and neck of the femur is the usual result in the Class-1 age group. In all four of the cases treated at the University Clinic there was disappearance of the bony nucleus, and in the last two cases there had been no obvious return of the head at eight and seventeen years of age, respectively. A good range of motion in flexion and extension, with limitation in abduction, usually results. In all cases healing occurred rapidly without sinuses.

Although a definite similarity is noted in Class 1 and Class 2, there is a suggestion of greater frequency of staphylococcal infection in the Class-2 age period. The cases in Group C with the extensive osteomyelitis were probably of staphylococcal origin. More bone destruction is seen at this period than in the infant group.

Eighty-five of this series of 113 cases fall into Class 3, the age period

TABLE II

STREPTOCOCCAL PYARTHROSIS WITHOUT BONE LESIONS

No. of Cases	Age	Type of Organism	Soft-Tissue Changes			
			Capsular Distention	Dislocation	Loss of Joint Space	None
1	14 months	Streptococcus hemolyticus	1			
1	17 months	Streptococcus hemolyticus		1		
1	23 months	Streptococcus non-hemolyticus	1			
2	4 years	Streptococcus hemolyticus	1			1
1	8 years	Streptococcus hemolyticus				1
2	9 years	Streptococcus hemolyticus (1) Streptococcus hemolyticus and staphylococcus aureus (1)	1			1
1	13 years	Streptococcus hemolyticus			1	
1	14 years	Streptococcus hemolyticus			1	
1	16 years	Streptococcus hemolyticus			1	
1	17 years	Streptococcus hemolyticus				1
1	19 years	Streptococcus hemolyticus		1		
13			4	2	3	4

between six and eighteen years. With the exception of one case in Class 2 and of one case in Class 4, all cases of sequestration of the head fall in this group. Twenty-four of the cases of dislocation of the hip occurred at this age, and all but one of the cases of epiphysiolysis developed in this period.

In fourteen cases the onset of symptoms developed after nineteen years of age (Class 4). In one case there was a dislocation of the hip, associated with a massive sequestration of the head and neck, and dislocation was present in two other cases in this group. Septic arthritis or ankylosis was the usual result in this group.

Age, therefore, would seem to play an important part in the frequency of occurrence of septic hips and in the severity of the reaction. The infant type (Class 1), if it survives the severity of the infection, tends to recover rapidly without sinuses or recurrence of the infection,

TABLE III

STREPTOCOCCAL PYARTHROSIS WITH BONE LESIONS

No. of Cases	Age	Type of Organism	Bone Lesions
1	3 years	Streptococcus hemolyticus	Sequestrated head; epiphysiolysis.
1	6 years	Streptococcus viridans	Osteomyelitis of neck; sequestrated head.
1	10 years	Streptococcus hemolyticus	Osteomyelitis of neck.
1	11 years	Streptococcus hemolyticus	Sequestrated head.
2	12 years	Streptococcus hemolyticus (1)	Osteomyelitis of neck (1).
		Streptococcus hemolyticus and streptococcus viridans (1)	Osteomyelitis of ilium (1).
2	17 years	Streptococcus hemolyticus	Osteomyelitis of neck, sequestrated head, dislocation (1).
			Osteomyelitis of ilium, dislocation (1).
8			

but with a loss or maldevelopment of the head, which eventually results in a moveable hip with a gluteal gait and a coxa-vara deformity. Class 2, patients from three to five years of age, shows a greater tendency to bone infection of staphylococcal origin with an increased tendency to recurrent infection and difficulty. Dislocation of the hip is surprisingly frequent in Classes 1 and 2, occurring in seven, or 50 per cent., of the fourteen cases. Disappearance of the head, temporary or permanent, is

TABLE IV

STAPHYLOCOCCAL PYARTHROSIS WITHOUT ROENTGENOGRAPHIC EVIDENCE OF BONE LESIONS

No. of Cases	Age	Type of Organism	Roentgenographic Appearance	
			Negative	Dislocation
1	4 weeks	Staphylococcus aureus		1
1	7 years	Staphylococcus aureus	1	
2	9 years	Staphylococcus aureus (1)	2	
		Staphylococcus aureus and streptococcus hemolyticus (1)		
2	12 years	Staphylococcus aureus	1	1
5	14 years	Staphylococcus aureus	4	1
1	15 years	Staphylococcus aureus	1	
1	47 years	Staphylococcus aureus	1	
13			10	3

TABLE V

STAPHYLOCOCCAL PYARTHROSIS WITH ROENTGENOGRAPHIC EVIDENCE OF BONE LESIONS

No. of Cases	Age (*Years*)	Type of Organism	Bone Lesions					
			Osteomyelitis of Ilium	Osteomyelitis of Neck	Osteomyelitis of Ischium	Osteomyelitis of Pubis	Osteomyelitis of Tuberosity	Cases with Multiple Lesions
1	3	Staphylococcus aureus	1					
2	5	Staphylococcus aureus	1					Osteomyelitis of the head and neck with dislocation (1).
2	7	Staphylococcus aureus			1			Osteomyelitis of the neck with dislocation (1).
1	8	Staphylococcus aureus		1				
2	9	Staphylococcus aureus		1				Sequestrated head and epiphysiolysis (1).
7	10	Staphylococcus aureus		2		1	1	Osteomyelitis of the ilium with dislocation (1). Osteomyelitis of the ilium with perforation of the acetabulum (1). Sequestrated head with dislocation (1).
1	11	Staphylococcus aureus			1			
3	12	Staphylococcus aureus	1	1				Osteomyelitis of the neck, epiphysiolysis, and sequestrated head (1).
3	13	Staphylococcus aureus	1	1				Osteomyelitis of the neck and shaft; epiphysiolysis (1).
7	14	Staphylococcus aureus	2	1				Osteomyelitis of the ilium and ischium (1). Osteomyelitis of the ilium with dislocation (1). Osteomyelitis of the neck with epiphysiolysis (1). Osteomyelitis of the neck; sequestrated head with dislocation (1).
1	15	Staphylococcus aureus	1					
2	17	Staphylococcus aureus	1					Osteomyelitis of the ilium with dislocation (1).
1	18	Staphylococcus aureus	1					
1	20	Staphylococcus aureus						Osteomyelitis of the ilium and neck (1).
1	32	Staphylococcus aureus		1				
1	40	Staphylococcus aureus	1					
36			10	8	2	1	1	14

common in these two groups. Class 3, the age period between six and eighteen years, is the period of greatest frequency, of the most extensive bone involvement, and of the most complications. Class 4, patients nineteen years of age and over, goes on to septic arthritis or bony or fibrous ankylosis.

THE DETERMINING FACTOR IN THE HIP REACTION

Numerous authors have maintained that in infants and in young children the septic hip joint which results from streptococcal infection tends to heal rapidly with retention of motion and with no recurrences. The septic hip joint which is caused by staphylococcal infection, however, is prone to slow healing, persistent draining sinuses, and marked bone changes with loss of motion or with ankylosis. Slowick has suggested that the type of organism is *not* the determining factor in these two types of reaction, but, rather, the localization of the organism, whether it be primarily a synovial infection or an intra-osseous lesion producing an osteomyelitis which secondarily invades the hip joint. He also asks the question, Does the streptococcus produce intra-osseous lesions at any age? In his group of sixty cases, he found no evidence of bone involvement in the streptococcus group. However, he stated that nine cases of staphylococcal lesions were primarily synovial in origin and resembled the streptococcus group in their reaction, and twenty-eight cases were primarily bony in origin.

Table I illustrates the types of lesions produced by the streptococcus and by the staphylococcus in patients under six years of age. These were essentially the same except that osteomyelitis of the ilium was present in two cases in Class 2, Group B, in the staphylococcus group, and in Class 2, Group C, there occurred a case of pathological dislocation and a case of osteomyelitis of the neck and head of several years' duration, which probably were due originally to a staphylococcal infection. No osteomyelitis was noted in the streptococcus cases in these earlier years of life, with the exception of a sequestration of the head which may have been and probably was on a vascular basis.

Table II illustrates thirteen cases of septic hips of proved streptococcal origin without evidence of osteomyelitis. Two cases of dislocation of the hip were seen in this group.

Table III demonstrates eight cases of proved streptococcal pyarthrosis associated with definite osteomyelitic areas. Two of these patients had osteomyelitis of the ilium; three had sequestration of the head of the femur; four had osteomyelitis of the neck of the femur; and one had epiphysiolysis.

Table IV shows thirteen cases of staphylococcal pyarthrosis without bone lesions with negative roentgenographic findings in ten and dislocation of the hip in three. These cases are quite analogous to the thirteen cases of streptococcal pyarthrosis without bone lesions but with dislocation of the hip in two cases.

TABLE VI

CLINICAL RESULTS IN GROUP A (TREATED CONSERVATIVELY)—12 CASES

Cases	Gait	Range of Motion
2	Normal	Normal
3	Good	At least 50 per cent. normal
3	Fair	Ankylosis or marked limitation in good position
1	Poor	None; poor position
2	Not stated	Not stated
11*		

* One of the twelve patients in this group died.

TABLE VII

CLINICAL RESULTS IN GROUP B (TREATED SURGICALLY)—42 CASES

Gait	Cases	Range of Motion	Cases
Normal	8	Normal	9†
Good	17	Partial	15
Fair	4	Bony ankylosis**	11
Poor	5		
Not stated	1		
	35*		35

* Seven of the forty-two patients in this group died.
** All patients with ankylosis were free from gluteal gait.
† One gluteal gait classified as good gait.

Table V presents thirty-six cases of staphylococcal pyarthrosis with roentgenographic evidence of lesions which, in all probability, were primarily bone lesions and secondarily joint lesions. Sixteen of these patients had osteomyelitis of the ilium; fourteen had osteomyelitis of the neck of the femur; seven had dislocation of the hip; and four had epiphysiolysis.

We feel that these studies produce convincing evidence of the truth of Slowick's contention that the organism itself does not determine the type of reaction in septic hip-joint lesions, but, rather, that the *localization of the primary infection* is the *determining factor*. Cases of primary synovial infection of the hip joint, whether streptococcal or staphylococcal in origin, have the same characteristics of rapid healing with retention of motion and freedom from recurrence. Cases of primary osteomyelitis with secondary hip invasion, whether streptococcal or staphylococcal in origin, have the same delayed healing, persistence of sinuses, complications, and recurrences, as long as the osteomyelitis remains active.

TREATMENT

It is impossible in this paper to give the detailed study of the treatment employed in Groups A, B, and C. It will be remembered that the

TABLE VIII

Dislocation of the Joint in Pyarthrosis of the Hip

Clinical Group	Age Period	No. of Cases	Deaths	Dislocation				Fate of the Head							Acetabular Changes		
										Reduction (17 Cases)			Persistent Dislocation (11 Cases)					
										Motion	Ankylosis		Motion	Ankylosis				
				Pathological	Pathological with Sequestration	Surgical (Intentional)	Accidental	Surgical Removal	Absorption		Fibrous	Bony		Fibrous	Bony	Oblique	Septic Arthritis	Shelf Formation
A	0–2	1		1					Bony nucleus	Good						1		
	3–5	0																
	6–18	2		2					2	50%		1				1		
	19+	1		1					1	50% +							1	1
B	0–2	2		1		1			2	Good (2)						1		
	3–5	2		1			1		2	Good (1)	1					1		1
	6–18	5	1	2	1	1	1	1	3	50% (1)		2			1	2		
	19+	1	1	1														
C	0–2	0																
	3–5	2		2				1+ neck	1	Flail					1			
	6–18	17	3	12	5			5	5	50% (1)	2	2	Good (1) 50%+ (3) 30% (1)	1	3	9		
	19+	1	1	1														
		34	6	24	6	2	2	7	17	9	3	5	5	1	5	15	1	2

TABLE IX

SEQUESTRATION OF THE FEMORAL HEAD

Age (*Years*)	No. of Cases	Organism				Associated Factors				
		Staphylococcus Aureus	Streptococcus Hemolyticus	Streptococcus Viridans	Streptococcus Hemolyticus and Streptococcus Viridans	Dislocation	Epiphysiolysis	Osteomyelitis of the Neck	Osteomyelitis of the Ilium	None Associated
3	1		1				1			
4–5	0									
6	1			1				1		
7	0									
8	2					1	1	1		
9	3	1				1	2			
10	2	1				1	1	1		
11	0									
12	3	1			1	1	1	2		
13	3	1					1	1		2
14	4	2				1	2	2		1
15–16	0									
17	1		1			1		1		
18–21	0									
22	1									1
	21	6	2	1	1	6	9	9		4

twelve cases in Group A were treated *conservatively* except for late drainage of soft-tissue abscesses in five cases. The forty-two cases in Group B were treated *surgically;* an arthrotomy of the hip was performed in each case. In some cases this was associated with resection of the head and reduction of the dislocation, and in some with resection of the osteomyelitic areas. Obviously the patients in Group A were less seriously ill than those in Group B; otherwise arthrotomies would have been performed on these patients. Patients in Group C were treated by late incision and drainage, saucerization, sequestrectomy, and correction of deformities.

Table VI shows the clinical results obtained from the conservative treatment. Good functional results were secured in 45 per cent. of these cases, and fair results in 27 per cent., making a total of 72 per cent. of the cases in which the results were fair.

The clinical results obtained from the surgical treatment are presented in Table VII. Seventy-one per cent. of the patients in this group who survived had good function and 11 per cent. had fair function, making a total of 82 per cent. who had fair function. In all cases in which the head was removed surgically and in which there was more than 30 degrees of motion a gluteal gait developed.

The clinical results of the surgical treatment of pyarthrosis of the hip, demonstrated in Tables VI and VII, show freedom from drainage in all surviving patients and a satisfactory gait in the majority, even though ankylosis or limited motion in the joint is present. Although surgically the results are not good in relation to normal function, they are quite satisfactory from the patient's standpoint, for there is freedom from infection and pain and the patient has a useful weight-bearing extremity. Roentgenographic examination in such cases usually shows loss of the head of the femur, ankylosis, dislocation with ankylosis, etc.

There is not enough essential difference in the clinical results between the cases treated conservatively and those treated surgically to draw conclusions as to the need of operation in all septic hips. Although a simple arthrotomy may not be a harmful procedure, we see no definite indication for arthrotomy unless there is pus to be drained or an osteomyelitic focus to be eradicated.

FREQUENT COMPLICATIONS ASSOCIATED WITH THE SEPTIC HIP

Pathological Dislocation of the Hip Joint

Dislocation of the joint is a frequent complication in pyarthrosis of the hip. This occurred in thirty-four cases of this series,—in seven in Classes 1 and 2, in twenty-four in Class 3, and in three in Class 4. Pathological dislocation of the hip generally takes place when the hip is in a position of flexion, adduction, and internal rotation; this position is generally assumed after the capsule has been distended and ruptured. Only two hips in this group dislocated while on our Service, and these dislocations were the result of failure to prevent the patients from assuming this dangerous position. Traction with the leg in extension and slight abduction will prevent this accident in the majority of cases. Table VIII shows the clinical group and the age classes in which the dislocations occurred, the fate of the head, the number of cases with reduction and their end results, and the number with persistent dislocation and their end results.

There were six deaths among the thirty-four patients. Twenty-four cases showed pathological dislocation alone; six were associated with sequestration of the head. In two more, on incision and drainage of the joint, dislocation was found to have occurred; these dislocations were not reduced, in order to increase the chance of drainage. In two cases dislocation was accidental,—one followed excision of the greater trochanter and the other occurred when traction was inadvertently removed.

The fate of the head in this group of cases in which dislocation complicated the septic joint is demonstrated in Table VIII. The head was removed surgically in seven cases because of sequestration and was absorbed spontaneously in seventeen. Six patients in this group died, so that in only four cases did the femoral head survive the complication of dislocation; in each of these four cases the dislocation remained unreduced. It is possible that, in performing an arthrotomy on a septic

TABLE X

FATE OF THE SEQUESTRATED HEAD

Clinical Group	Age Period (*Years*)	No. of Cases	Dislocation	Epiphysiolysis	Osteomyelitis of the Neck	No Associated Changes	End Results	
							Surgical Removal	Conservative
A	0–2	0						
	3–5	0						
	6–18	1				1		Fibrous ankylosis in poor position. Arthrodesis performed later. Loss of head.
	19+	0						
B	0–2	0						
	3–5	1		1			Normal motion, gluteal gait.	
	6–18	8	1	4	4	2	Normal motion, gluteal gait (2). Fibrous ankylosis, no motion (1). Died (1). Dislocation reduced, 50% motion, gluteal gait (1). Bony ankylosis, good gait (2).	Loss of head, fibrous ankylosis, and no motion (1).
	19+	0						
C	0–2	0						
	3–5	0						
	6–18	10	5	4	5		Died (3). Fibrous ankylosis, no motion (4). Motion 50%, gluteal gait (1). Bony ankylosis (1). Bony ankylosis to the ilium (1).	
	19+	1				1	Fibrous ankylosis, no motion.	
		21	6	9	9	4	19	2

hip with dislocation, it is occasionally wise to leave the head displaced for a time in order that more satisfactory drainage may take place. The head may be replaced after the acute reaction has subsided. In seventeen cases reduction of the dislocation of the hip was obtained; in three cases fibrous ankylosis developed and in five bony ankylosis occurred. Four of this group of patients had good motion in the hip; four had 50 per cent. or more of the normal range of motion; and one had a

TABLE XI

SUMMARY OF 113 CASES OF SEPTIC HIP

Age Range:		
4 weeks to 53 years		
Clinical Groups:		
A		12 cases
B		42 cases
C		59 cases
Analysis of Cases:		
Total number of cases		113
Total number of hip joints involved		124
Number of cases of bilateral involvement		11
Number of deaths (two bilateral cases)		14
Lesions:		
Osteomyelitis of the ilium		25 cases
Osteomyelitis of the pubis		3 cases
Osteomyelitis of the ischium		3 cases
Osteomyelitis of the femoral neck		30 cases
Pathological fracture of the femoral neck		4 cases
Complications:		
Disappearance of the femoral head		43 cases
Surgical removal	19 cases	
Non-surgical	24 cases	
With dislocation	17 cases	
Sequestrated head	2 cases	
Absorption	5 cases	
Sequestration of the femoral head		21 cases
Epiphysiolysis (produced by traction in 2 cases)		9 cases
Dislocation of the femoral head		34 cases
Nearthrosis (at epiphyseal line with fusion of head to acetabulum or ilium)		8 cases
Coxa magnum		5 cases

flail hip. In eleven cases the dislocation persisted, with five cases of bony ankylosis and one case of fibrous ankylosis. There was a good range of motion in one of these cases of persistent dislocation, 50 per cent. or more of normal in three cases, and 30 per cent. in the fifth case.

Fourteen of the twenty-eight surviving hips had good or fair range of motion; five of these hips were still dislocated.

The complication of dislocation of the hip, associated with septic hip, may have been nature's way of improving drainage of the septic joint, but in general it resulted in a poorly functioning joint.

Sequestration of the Femoral Head

In studying this problem the questions to be considered are:

1. Why does the head sequestrate?
2. What happens to the sequestrated head if it is not removed?
3. What is the result if the sequestrated head is removed?

Table IX shows the age periods in which sequestration occurred and the organisms responsible in those cases where they were isolated.

TABLE XII

ANALYSIS OF CASES IN WHICH ANKYLOSIS OCCURRED

Area	Bony Ankylosis		Fibrous Ankylosis	
	Age Group	*Cases*	*Age Group*	*Cases*
Head to acetabulum	A	2	A	4
	B	10	B	8
	C	10	C	16
Head or neck to ilium		5		5
Neck to acetabulum after sequestrectomy of head		5		13
Total		32		46

In ten of these cases the organisms were known; six cases were caused by staphylococci and four by streptococci. It is interesting to note that dislocation of the hip was associated with six of these cases, epiphysiolysis with nine, and osteomyelitis of the neck with nine, leaving only four cases of sequestration of the head without definite pathology to account for the sequestration. Undoubtedly interference with the blood supply to the head itself plays a part in the sequestration. It would seem from Wolcott's[2] excellent anatomical dissections that more chance for damage to the branch of the median circumflex artery in the posterior capsular location would be produced by Ober's incision than by the anterior or anterolateral approach. Thrombosis of the ligamentum teres, or rupture of the ligamentum teres as necessarily occurs in dislocation of the hip, is undoubtedly a factor in some cases of sequestration of the femoral head.

The fate of the sequestrated head is demonstrated in Table X. It will be noted that there were twenty-one sequestrated heads in this group and nineteen were removed surgically. Several of these were not removed at the initial arthrotomy, but presented themselves spontaneously in the wound at subsequent dressings and were removed. In two cases the heads were not removed, but later were completely absorbed *in situ* with resultant fibrous ankylosis. Three of the nineteen patients had normal motion, but a marked gluteal gait concealed by the Achilles push-off action that obscures the pelvic drop, a trick motion which patients with positive Trendelenburg symptoms learn. Two patients had 50 per cent. of normal motion with a definite gluteal gait. Six patients had fibrous ankylosis with little or no motion, and four had bony ankylosis,—in three ankylosis developed in the acetabulum and in one the joint dislocated and ankylosed to the ilium. Four of the twenty-one patients died. The amount of resultant shortening of the extremity in this group has not been compiled in this study.

The complication of sequestration of the head is, therefore, a serious obstacle to normal function of the hip.

Disappearance of the Femoral Head

There were forty-three cases in which the femoral head was either removed surgically (nineteen cases) or absorbed spontaneously (twenty-four cases). The spontaneous absorption of the head occurred in seventeen patients with dislocation of the femoral head, in two patients with sequestration of the head which was not removed, and in five patients under six years of age. Absorption of the femoral head in our series resulted from pyarthrosis of the hip in patients under six years of age, from the complications of sequestration of the head, or from pathological dislocation of the hip joint.

CONCLUSION

A study of the end results (Tables XI and XII) of the treatment of the subacute and chronic septic hip joints, with which this paper deals almost entirely, shows a relatively low death rate and a high frequency of healing of the infection. From this standpoint the results are satisfactory, but of the 113 cases there were only seven in which the hip was normal. Twenty-three patients with septic arthritis had a functional joint with at least 50 per cent. of normal motion. The remaining eighty-three cases demonstrated numerous severe complications, resulting in irreparable functional damage to the hip joint proper. The poor prognosis in cases in which there are complications such as dislocation of the hip, sequestration of the head, and epiphysiolysis, is readily confirmed by the results in this paper. Inasmuch as neither dislocation of the hip, with the exception of two cases, nor epiphysiolysis developed while under our care, we feel that they are preventable complications in the most part if an arthrotomy is performed early in the course of the disease and if the hip is fixed in mild abduction and extension by traction or plaster.

The results here recorded point to a more favorable prognosis in the case of a primary synovial lesion, whether due to streptococcal or staphylococcal infection. If the patient survives the acute infection, rapid healing with good motion and no recurrence is the rule. If the lesion is primarily osteomyelitic in origin, the prognosis is much poorer and early and radical surgery is necessary. The age of the patient plays a definite part in the type of lesion and is of importance from a prognostic and therapeutic standpoint. Under two years of age, there is very good expectation that the lesion is primarily synovial; under five years, without evidence of bone infection, the prognosis is good. Between six and eighteen years is the period of the greatest number of complications. It is during this period that osteomyelitis most commonly develops, and the prognosis for function is much poorer.

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ENLARGED INTERMETATARSOPHALANGEAL BURSAE OF BOTH FEET

A Case Report

BY HERMAN S. LIEBERMAN, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases *

As is now coming to be recognized, the intermetatarsophalangeal bursae are four in number and are situated between the heads of the metatarsal bones; the three medial bursae are almost constant, the fourth is only occasionally present.

The presence of intermetatarsophalangeal bursae is not mentioned in American or in English text-books on anatomy, although Gruber in discussing the subject recognized these bursae as far back as 1795. Just as their presence anatomically has been ignored, so has their clinical significance been almost completely neglected.

Probably the first to recognize disturbances of this bursa clinically was Hertzler in 1926. Many of his cases had been previously treated for periods averaging from a few months to five years under the diagnosis of weak feet or metatarsalgia. Relief of symptoms promptly followed the employment of such procedures as are commonly used to control inflamed bursae.

Next to call attention to this condition clinically was Roberts, in March 1929. He reported twenty-six cases of metatarsal bursitis, of which fourteen were cured by conservative and twelve by operative methods.

Differential diagnosis depends upon:

1. Circumscribed tenderness situated between the heads of the metatarsal bones;
2. Pain in the anterior portion of the foot when this area is compressed laterally;
3. Pain caused by hyperflexion of the toes, due to pressure on the bursae through tension of the overlying tissue.

The author has recently had the opportunity of treating the following case:

The patient, an adult female of thirty-eight years, a dancer by profession, was admitted to the Hospital because of painful masses on both feet, of several years' duration. About five years previously, she had first noticed that the left leg became more tired than the right. This discomfort had continued until about three years before admission, when the patient had begun to suffer quite severe pain near the first left metatarsophalangeal joint, associated with some swelling and a mass. This condition had persisted despite treatment with metatarsal padding and physiotherapeutic measures. Eight months before admission, following an attack of acute tonsillitis, the patient had experienced what was termed "inflammatory rheumatism", involving the foot, the ankles, and the knees. At this time, she had noticed a mass about the fifth right metatarsophalangeal joint. Since this initial attack, she had experienced three others, chiefly localized at the site of the masses. Pain and swelling had persisted in these localities, so that walking had become quite difficult.

* Service of S. Kleinberg, M.D.

Examination showed an early bilateral hallux-valgus deformity with depression of the anterior metatarsal arch. On the left, a swelling was present between the heads of the first and second metatarsal bones. This consisted of a small tender mass, about two centimeters in diameter, unattached to the overlying skin. A smaller tender area was present on the right foot between the heads of the fourth and fifth metatarsal bones, and, upon upward pressure on the plantar surface, a distinct mass was likewise discernible. Roentgenographic examination was negative.

At operation, a two-inch incision was made on the dorsal surface of the left foot, extending upward from the webbing of the toes, between the first and second metatarsal bones. Directly beneath the skin a large cystic mass was found lying between and adhering to the first and second metatarsals. A short cystic projection was discovered, extending proximally between the adjacent bones. This entire mass was completely removed. A similar procedure was performed on the right side, the incision having been

FIG. 1-A

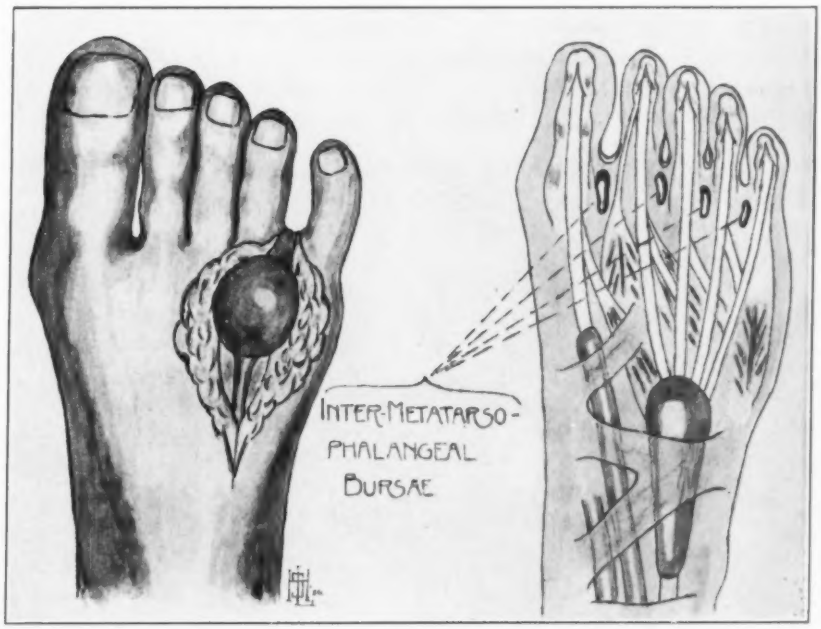

FIG. 1-B FIG. 1-C

Fig. 1-A and Fig. 1-B: Appearance of enlarged intermetatarsophalangeal bursae when exposed at operation.

Fig. 1-C: Appearance of normal intermetatarsophalangeal bursae. *(Sketched from Fig. 408, p. 363, Vol. II, "Hand Atlas of Human Anatomy" by Werner Spalteholz.)*

made over the dorsum of the foot between the fourth and fifth metatarsal bones. A cystic mass, similar to but somewhat smaller than that on the left foot, was found.

Histological study showed a dense, highly cellular layer of young, actively proliferating fibroblasts,—a membrane which was found to be invaginated and lined by flattened synovialike cells. There was a slight round-cell infiltration. The specimen from the right foot was similar to that of the left with the addition of areas of necrosis and leukoid degeneration with considerable mononuclear infiltration. The pathological diagnosis was chronic bursitis.

The postoperative course was uneventful, and the patient was discharged in two weeks, walking and free from pain.

The patient had had symptoms of over five years' duration. No evidence of any mass had appeared until three years prior to admission. The patient had been treated during this period by the usual methods employed for relieving pain in cases of metatarsalgia, with slight relief of symptoms. In this case, the condition no doubt was initiated as a result of frequent trauma induced by the patient's occupation as a dancer, with perhaps an exacerbation or aggravation of preexisting bursitis, caused by the tonsillitis eight months before admission. Because of the size of the masses, operative intervention was considered the best means of treatment.

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TORTICOLLIS

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From the Hospital for Joint Diseases *

The author may be accused of splitting hairs, but to him torticollis, due to a shortened clavicular head of the sternomastoid muscle, is a distinct clinical entity. This condition has been termed "clavicular" torticollis.

In the normal person the clavicular head blends with the sternal head below the middle of the neck, and is an individual unit only at its origin. A small hiatus is present between the two heads which cannot be seen even with the muscle tensed. Should torticollis take place in such an individual, tension on the shortened muscle will make the sternal head very conspicuous, but the clavicular portion *may* be seen as a tense cord for a very short distance, beginning at the clavicle and close to the sternal head. No hiatus is visible. The head proper is not only tilted to the same side, but the chin is pointed well away from that side. The *sternal* muscle is the predominating factor. The *contour* of the neck and shoulder is *not* affected because of the oblique course of the muscle, from behind forward.

"Clavicular" torticollis presents a different picture entirely. The clavicular portion of the muscle is very prominent. It extends in a longitudinal line from the mastoid almost to the midpoint of the clavicle and is *not* blended with the sternal portion at all (Figs. 1-A, 1-B, and 2-B). There is a distinct hiatus between the muscle bellies, extending in some cases from the origin to the insertion (Fig. 2-B). Here the sternal portion is more a part of the clavicular one. In fact, in some cases the sternal head cannot even be seen (Fig. 1-A). Because its course is longitudinal instead of oblique, it pulls the head directly to the same side, but does not rotate the chin to the

FIG. 1-A FIG. 1-B

Case 5. Before operation.

Fig. 1-A: Note division of supraclavicular fossa by clavicular head. Sternal head is not seen. Broadening of neck is quite apparent. Note scars of two previous attempts at correction.

Fig. 1-B: Clavicular head is not blended with sternal head. Note its straight course from clavicle to mastoid.

*Service of H. C. Frauenthal, M.D.

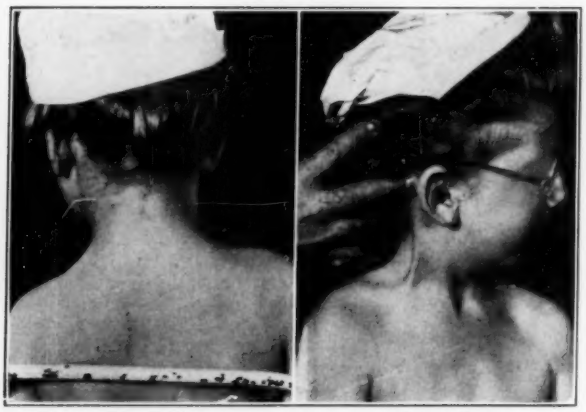

FIG. 2-A FIG. 2-B

Case 7. Before operation.

Fig. 2-A: Webbing of right side of neck. Neck broadened. Normal outline of neck is disturbed,—longitudinal line meeting a concave one. Loss of inward dip of neck as it approaches shoulder outline.

Fig. 2-B: Note pronounced hiatus between the clavicular and sternal heads, bisected supraclavicular fossa, and course of clavicular head.

FIG. 3-A FIG. 3-B

Case 7. After operation.

Fig. 3-A: Note outline of neck and shoulder, especially the inward dip of the neck near its base.

Fig. 3-B: Supraclavicular fossa reestablished. No hiatus.

FIG. 4-A FIG. 4-B

opposite side (Figs. 4-A and 5-A). Also, because of its aberrant course, it affects the normal contour of the neck and shoulder and gives the neck a very broad appearance. On the affected side (Fig. 5-A) the neck appears webbed. The outline is a straight line dropped from the mastoid, crossing a concave curve. This straight line obliterates the normal inward dip of the neck line just before it blends with the outline of the shoulder (Figs. 2-A, 4-B, 5-B, and 7). It also divides the supraclavicular fossa into two parts (Figs. 1-A and 2-B).

Ordinary operative measures will correct the tendency to hold the head tilted to one side, but will not restore the normal curved outline of the neck. The clavicular head becomes reattached to its origin and even in its length-

FIG. 4-A and FIG. 4-B

Case 2. After operation.

Fig. 4-A: *Not* one of the series of transplantations. Head is tilted to left, but chin is *not* turned to right. Broad neck on left.

Fig. 4-B: Webbing of neck on left side; disturbed outline; loss of inward dip of base of neck.

ened state stands out prominently, away from the neck proper. Although the head deformity is overcome, the cosmetic deformity is unimproved (Figs. 4-A and 4-B).

The author's series consisted of ten cases. In the first case a tenotomy of the sternal and clavicular heads was done, plus a myotomy of the platysma myoides and a section of the deep fascia. In the second case, in addition to these steps, the clavicular head was sutured to the undersurface of the sternal belly (Figs. 4-A and 4-B).

In neither case did the head deformity recur, but the cosmetic effect was anything but beautiful. These poor results were seen when the plasters were removed after five weeks. There was a complete reformation of the severed muscle (Figs. 4-A and 4-B). In both cases, a second operation was refused.

FIG. 5-A FIG. 5-B

Case 8. Before operation.

Fig. 5-A: Head tilted, but not the chin; left side of neck is broader. Even the outline of the mandible is obscured.

Fig. 5-B: The muscle in this case was so thick that it hid almost the entire ear. Note the straight course of this muscle and how sharply it meets the concave outline of the neck and shoulder.

FIG. 6-A FIG. 6-B

Case 8. After operation.

Fig. 6-A: Clavicular head cannot be seen.

Fig. 6-B: Compare with Fig. 5-B.

To eliminate these eventualities, the following technique was originated.

OPERATIVE TECHNIQUE

An oblique incision, about two inches long, is made between the two heads of the sternomastoid muscle. The incision begins just above the clavicle and extends toward the mastoid. The clavicular head is isolated and tenotomized close to the clavicle. It is then separated along its course up to its bifurcation with the sternal portion and in some cases right up to the mastoid. All structures in front of the deep layer of cervical

FIG. 7 FIG. 8

Fig. 7: Case 9. Before operation. Note prominence of weblike appearance of right side of neck.

Fig. 8: Case 9. After operation. Normal symmetry of both sides of neck.

fascia are cut as far back as the anterior margin of the trapezius. The fascial compartment of the sternal belly is then cut from the sternum to a point just *above* the bifurcation. The fascia surrounding this muscle is now almost completely separated from it. This is not so simple in all cases. The clavicular belly is now swung under the sternal one and fixed in that position by two sutures. The fascial compartment is then closed with a continuous stitch. If, at this time, it is found that the sternal head is somewhat contracted, it should be tenotomized close to the sternum. Of the eight cases in which this operation was performed sternal tenotomy was unnecessary in four. The skin is closed with a subcuticular stitch.

After-Care

The after-treatment consists of a Calot jacket, applied forty-eight hours after operation and worn for five weeks. This is followed by the wearing of a leather collar for an additional six to nine months. This immobilization is constant for all forms of torticollis.

End Results

In every one of the eight cases operated upon both the tilting of the head and the cosmetic deformities were completely corrected. (See Figures 3-A, 3-B, 6-A, 6-B, and 8.) Postoperative results range from six months to three years.

SUMMARY

Torticollis, due to a shortened clavicular head of the sternomastoid muscle, produces a cosmetic deformity of the neck which can be corrected by a physiological transplantation of the offending muscle. This procedure, employed in eight cases, gave uniformly excellent results. There were no recurrences.

NOTE: Since the submission of this article for publication in May 1936, three other cases have been added to this series. All three patients were operated on in June. One of them was the patient in Case 2, who had previously refused reoperation. The results in these three cases are as excellent as those reported in the article.

THE FUNCTION OF SEMILUNAR CARTILAGES *

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There has been much speculation concerning the function of the intra-articular semilunar fibrocartilages. The functional rôles assigned to these cartilages are as follows:

1. Protection of the articular hyaline cartilages by absorbing shocks;
2. Increasing of joint stability by deepening the female portion of the joint (tibial condyles) for reception of the male portion (femoral condyles);
3. Relieving incongruity and increasing mobility between the meshing surfaces of the femur and the tibia by acting as peripheral, elastic, movable washers.
4. Lubrication.**

In spite of the various functions assigned to the semilunar menisci, patients seem to get along quite satisfactorily following the extirpation of these cartilages. Sutton (1897) suggested that they are functionless remains of leg-muscle origins, which formerly arose intra-articularly.

In a short series of experiments on the knees of dogs it was noted that partial or complete meniscectomy was followed by some degeneration of the articular cartilages of the medial tibial and femoral condyles [1]. This observation suggests that the menisci do protect the articular hyaline cartilages. In an effort to throw further light on this problem the following experiments were conducted.

EXPERIMENTS

Dogs 1 and 2

The knee joints were opened by curved internal incisions. The lateral ligaments were cut and sutured, and the wound was closed as atraumatically as possible. Ninety days later both knees were found to be normal.

Dog 3

A complete extirpation of the left internal semilunar cartilage was done. One hundred and five days later the apparently normal joint was opened. The extirpated cartilage was replaced by a disc of glistening white tissue grossly like fibrocartilage (Figs. 1-A, 1-B, 1-C, and 1-D). There was a moderately severe degeneration of the articular cartilage of the internal femoral and tibial condyles.

Dog 4

Subtotal excision of the internal semilunar cartilage of the left knee was performed. Ninety-eight days later the extirpated meniscus was found to be replaced by a newly

* The experimental work was aided by a grant from the Fluid Research Fund of the Rockefeller Foundation to Stanford University School of Medicine.

** The most effective form of lubrication depends upon the formation of a film of the lubricatory fluid between the moving surface and its bearing. The wedge-shaped semilunar cartilages insure the formation of similarly shaped synovial films between the femoral and the tibial condyles (MacConaill).

FIG. 1-A

Dog 3. Showing the extirpated meniscus and the newly formed disc (pseudocartilage). Note the degeneration of the articular cartilage of the femoral and tibial condyles (105 days).

FIG. 1-B

Dog 3. Showing femoral and tibial condyles. *A*: pseudocartilage; *B*: normal extirpated cartilage.

formed disc of fibrous tissue (Fig. 2-A). The internal tibial and femoral condylar articular surfaces had degenerated considerably (Fig. 2-B).

DOG 5

This animal was a very young puppy. The internal semilunar cartilage of the left knee was completely excised. Two hundred and eighty-seven days later there was complete regeneration, and only a very slight amount of articular cartilage degeneration (Fig. 3).

DOGS 6 AND 7

The posterior horns of the internal semilunar cartilages were excised. One hundred and fifteen days later there was complete replacement and considerable degeneration of the articular cartilage (Fig. 4).

DOGS 8 AND 9

The middle third of each internal semilunar cartilage was excised. Seventy-five days later the defects were well filled in and the articular cartilages opposite them were somewhat degenerated (Fig. 5).

DOGS 10 AND 11

The anterior third of each internal semilunar cartilage was removed. One hundred and twenty-five days later the defects were well filled in with the pseudocartilage. There was a moderate amount of degeneration of the articular cartilages (Figs. 6-A, 6-B and 6-C).

DOGS 12 AND 13

The internal halves of the medial semilunar cartilages were excised circumferentially (Fig. 7-A), in a manner similar to excision of the mesial fragment of a bucket-handle tear.

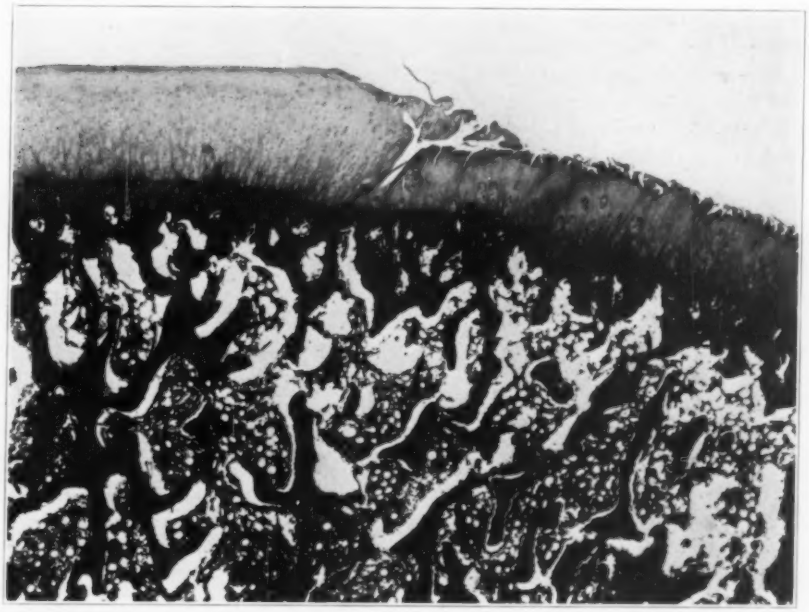

FIG. 1-C

Dog 3. Section through femoral condyle, showing degeneration of articular cartilage.

Ninety days later there was not the slightest evidence of false-cartilage formation (since the incision nowhere approached the synovial membrane) and only the very smallest amount of degeneration of the articular cartilages (Fig. 7-B).

DOGS 14 AND 15

A partial excision of the *external* semilunar cartilages was done. Ninety days later there was only the slightest formation of false cartilage and a moderate amount of degeneration of the articular cartilages. This lack of false-cartilage formation is exactly what one would expect from the anatomy of the external semilunar cartilage. In the dog's knee the common extensor muscle has a long intra-articular tendon of origin from the lateral femoral

FIG. 1-D

Dog 3. Section through newly formed meniscus. Fibrous tissue only. No cartilage cells seen.

FIG. 1-D

condyle. This tendon passes downward in a groove over the anterolateral surface of the external semilunar cartilage (Fig. 8). The lateral and posterior surfaces of the meniscus are grooved for the popliteus tendon, leaving very little surface for attachment to the synovial membrane. Since the false cartilage arises from an ingrowth of synovial membrane, at the point of its detachment from the semilunar cartilage, it is not difficult to understand its lack of formation in removal of the external semilunar cartilage.

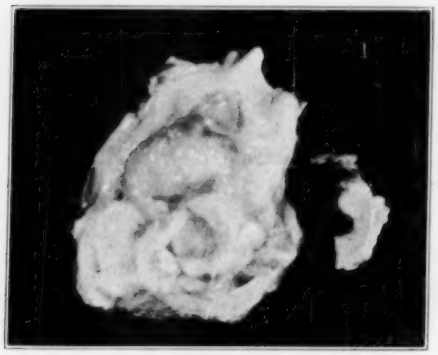

FIG. 2-A

Dog 4. Showing excised portion of internal semilunar cartilage (left knee). Note newly formed disc (pseudocartilage) and degeneration of articular cartilage of tibia.

FIG. 2-B

Dog 4. Pseudocartilage, *A*, removed from tibial condyle. *B* is the original semilunar cartilage excised. At left is shown the articular surface of the internal tibial condyle.

FIG. 3

Dog 5. Very young puppy, 287 days after complete extirpation of the internal semilunar cartilage (shown at right). Note excellent pseudocartilage. There is very little degeneration of the articular cartilage.

FIG. 4

Dog 7. One hundred and fifteen days following excision of the posterior half of the internal semilunar cartilage. Starting at bottom, note: (1) degeneration of articular cartilage of medial femoral condyle; (2) degeneration of corresponding portion of medial tibial condyle; (3) articular cartilage intact peripherally; (4) perfect replacement of posterior half of semilunar cartilage; (5) excised portion.

FIG. 5

Dog 8. Left and right knees, 75 days after excision of middle third of semilunar cartilage. Excised fragments are shown between the knees. There has been complete replacement with pseudocartilage. Note moderate degeneration of articular cartilages opposite the original defects.

SUMMARY

In four joints the capsule was opened without disturbing the semilunar cartilages. No degeneration of the articular cartilages occurred (ninety days).

In four joints the anterior thirds of the internal semilunar cartilages were excised. The excised portions were replaced by an ingrowth of firm connective tissue from the synovial membrane, grossly not unlike fibrocartilage. *The articular cartilages of the tibial and femoral condyles were slightly degenerated* (125 days).

Similar changes were observed following removal of the middle (four joints) and the posterior thirds (four joints).

FIG. 6-A

FIG. 6-A

Dog 11. One hundred and twenty-five days after excision of anterior third of the internal semilunar cartilage. Note from left to right: *above*, the excised anterior third of the cartilage; *below*, the complete internal semilunar cartilage, showing how perfectly the excised portion is replaced by pseudocartilage; the internal tibial condyle showing degeneration of the articular cartilage; the external tibial condyle (normal); and last, at the far right, the normal external semilunar cartilage.

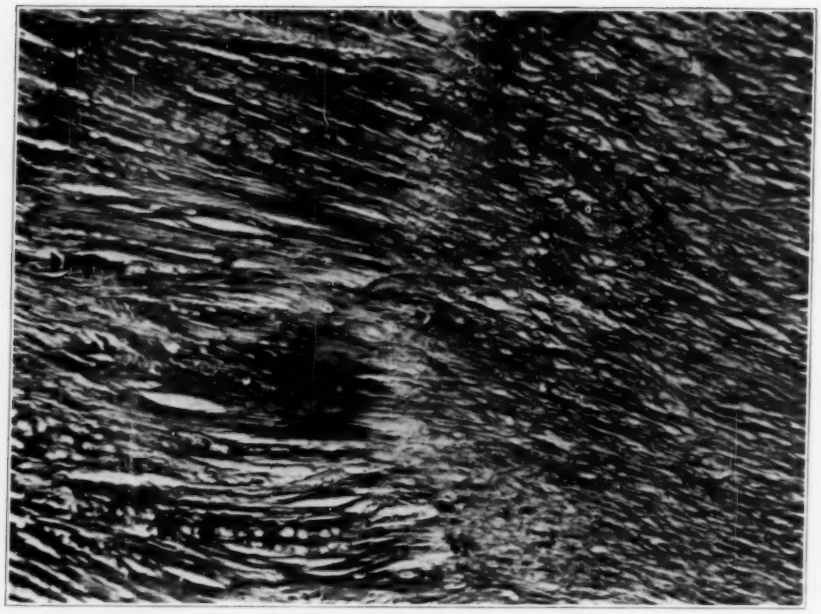

FIG. 6-B

Dog 11. Photomicrograph, showing abrupt transition from the normal fibrocartilage (left) to pseudocartilage (connective tissue) on right.

FIG. 6-C

Dog 11. Section through articular cartilage of medial femoral condyle. Note degeneration of superficial layers.

FIG. 7-A

Diagram illustrating operation done on Dogs 12 and 13. Dotted area indicates portion of semilunar cartilage removed.

FIG. 7-A

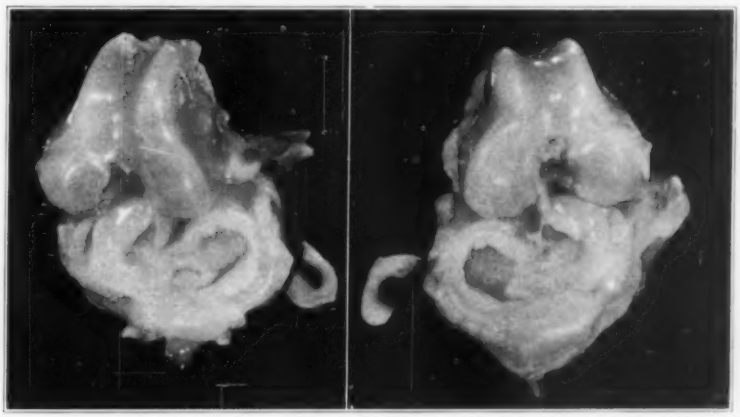

FIG. 7-B

Dog 12. Ninety days after excision of internal halves of internal semilunar cartilages. Excised portion shown. There is no evidence of pseudocartilage formation and practically no degeneration of the articular cartilage.

When the internal semilunar cartilages were completely extirpated or subtotally excised (three joints) an excellent false cartilage was formed, but a severe degeneration of the articular cartilages took place (especially in the older dogs).

Partial excision of the external semilunar cartilages (four joints) was followed by articular-cartilage degeneration, but practically no false-cartilage formation.

There was no false-cartilage formation and very little articular degeneration following removal of the internal half of the medial semilunar cartilages (four joints).

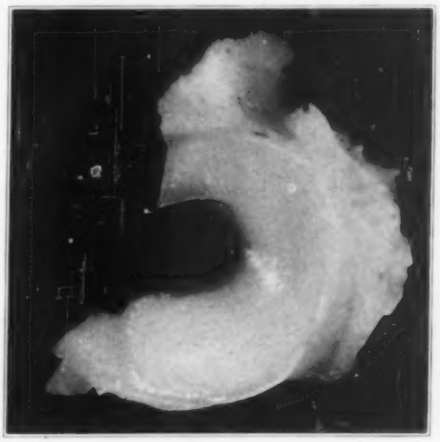

FIG. 8

External semilunar cartilage (right). Note groove anterolaterally and long groove for popliteus tendon.

CONCLUSION

When the internal semilunar cartilage of the dog's knee is extirpated, or a segment of it is excised, the resulting defect is filled in by an in-

growth of fibrous tissue from the synovial membrane. Grossly this newly formed tissue is indistinguishable from normal fibrocartilage. In spite of this replacement, considerable roughening and degeneration of the articular hyaline cartilages takes place. The amount of degeneration appears to be roughly proportional to the size of the segment removed, being greatest when a complete meniscectomy has been done. It also seems to be much less in young puppies than in older dogs. These findings indicate that the semilunar menisci serve to protect the articular hyaline cartilages, and that probably operative excision should be limited to removal of the mobile portion.

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DISLOCATION OF THE ELBOW REDUCED BY MEANS OF TRACTION IN FOUR DIRECTIONS

BY EDWARD H. CROSBY, M.D., HARTFORD, CONNECTICUT

New and easier methods of utilizing old and familiar principles already in use are of value. It is with this in mind that the author presents the following method of reducing dislocation of the elbow.

Regardless of the type of dislocation in an elbow, the reduction of the dislocation often causes considerable injury to the tissues around and in the joint. The method of four-direction traction minimizes injury to these tissues, thereby reduces the amount of postreduction swelling and pain, and, the writer feels, considerably shortens the period of convalescence.

Figure 1 shows the method of applying four directions of traction. The patient is placed on a stretcher with a folded sheet around the chest. The sheet is then tied or pinned to a cross-bar on the opposite side of the stretcher. This fixes the chest and gives countertraction. A four-inch muslin bandage, long enough to reach to the floor, is then placed around the arm above the elbow. This bandage is tied so that it forms a loop, the lower end of which is about six inches above the floor. The foot is placed in this loop for traction downward. A similar bandage is placed around the forearm with the elbow flexed at 90 degrees and is tied behind the operator. This gives traction laterally. The patient's wrist is grasped with the operator's left hand, thus producing traction upward, and the operator's right hand is free to manipulate the elbow joint.

FIG. 1

The patient is anaesthetized, and, when muscle relaxation has been reached, the operator gives traction in four directions by leaning backward, by pressing downward with the foot through the loop in the bandage, by pulling upward with the left hand, and with countertraction across the chest. The dislocation in the elbow joint is easily reduced by one operator with a minimum of injury to the joint.

The method described was suggested by the three-type-traction method of Dr. Merrill K. Lindsay.

AN UNUSUAL SHOULDER LESION

BY DAVID M. BOSWORTH, M.D., NEW YORK, N. Y.

From the Orthopaedic Clinic, St. Luke's Hospital, New York City

The following case of an unusual shoulder lesion was studied by the author in conjunction with several other surgeons. The only description of a similar lesion that could be found in the literature was that by Köhler.[1] In his book he states that the lesion is physiological and not to be looked upon as pathological, although such a configuration is rarely met with.

FIG. 1-A

Lesion in right humeral epiphysis.

FIG. 1-B

Left humeral epiphysis, for comparison.

FIG. 2

Right humeral epiphysis six years later, without treatment or operative interference. Note dense area behind lower margin of abscess wall, which proved to be a sequestrum.

A boy, fourteen years old, was seen in March 1929 with a history of low-grade pain in the right shoulder of six years' duration, which had gradually become worse. The past history was negative for injuries, operations, or illness.

Examination showed a generalized limitation of motion in the shoulder, amounting to 20 per cent. in all directions, with spasm and protection of moderate degree. There was no swelling, crepitation, or external sign of pathology. No muscular atrophy of the shoulder girdle, arm, or forearm was present. A roentgenogram showed a raylike, coarsened structure of the greater tuberosity of the humerus as compared with the normal. (See Figures 1-A and 1-B.)

The case was diagnosed as an epiphysitis such as is found in the tibial

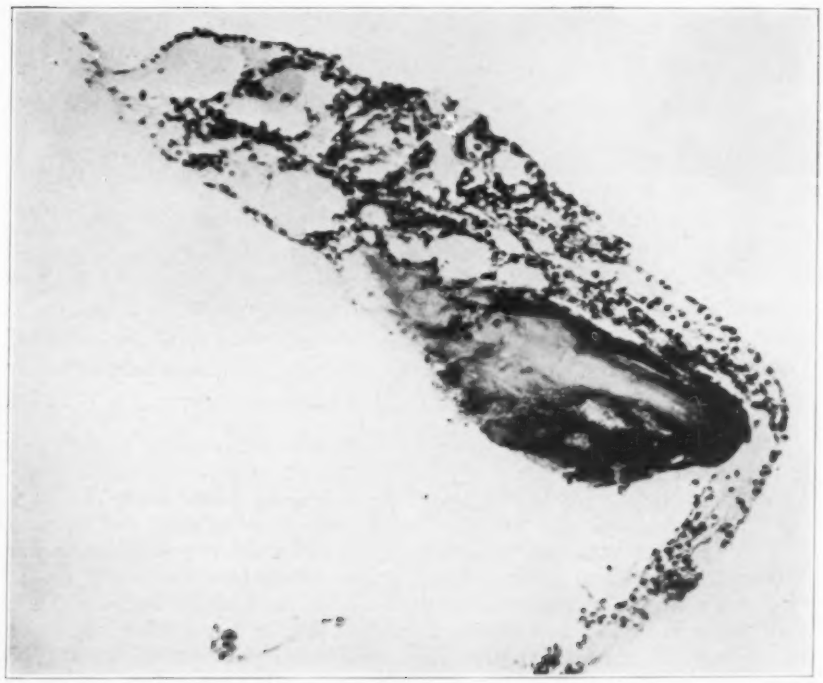

FIG. 3

Photomicrograph through the sequestrum, showing dead bone without cells and amorphous deposits about it with inflammatory soft-tissue reaction.

tubercle and in the head of the femur, and drilling for new blood supply and biopsy was advised, but was refused.

The patient disappeared and returned six years later in March 1935. The symptoms had continued in the interim, becoming worse during the two months prior to his return. Examination revealed essentially the same conditions as had been found six years before. However, a roentgenogram (Fig. 2) showed within the base of the greater tuberosity a pocket which contained a small sequestrum. At operation, March 22, 1935, a sequestrum was found lying in granulation tissue. Sections of this showed bone without living cells, degenerating on the margins into amorphous material. (See Figure 3.)

The lesion described has been considered in the past as an epiphysitis. In the present case, however, such a lesion, after six years, was found to have caused sequestration which resembled a localized osteomyelitis.

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LOCKING OF THE HIP JOINT DUE TO OSTEOCHONDROMA OF THE LESSER TROCHANTER

BY DAVID POVERMAN, M.D., NEW YORK, N. Y.

Senior Resident Orthopaedic Surgeon, Hospital for Joint Diseases

This case is considered worthy of presentation because of the extreme rarity of the presenting symptom. A careful search of the English literature reveals very few cases of locking at the hip joint and no case in which locking was due to a tumor. Of course, cases are frequently reported in which there is limitation of motion due to actual obstruction.

The patient, No. 56287, female, aged twenty-seven, was admitted to the Service of Dr. Samuel Kleinberg on December 3, 1935. Her chief complaints at this time were weakness of the right lower extremity of five years' duration, pain in the right groin of one year's duration, and locking of the right thigh at the hip joint (six attacks in eight months).

The patient stated that she had been perfectly well until five years before admission, when she had first begun to notice a weakness of the right lower extremity which was aggravated when she walked more than usual or when she operated the brake of her car. The symptoms at this time were not of sufficient severity to cause her much concern. The symptoms had increased very gradually and four years later she had found it difficult and painful to walk fast or for long distances. During the eight months prior to admission she had found on six occasions that her hip had locked in extension. Each time that this had occurred she was lying in bed and suddenly found that she was unable to flex the right thigh. After a series of motions, which usually consisted of internal rotation and attempts at flexion, the thigh perceptibly unlocked and motion at the hip joint was again free.

FIG. 1

Preoperative roentgenogram of osteochondroma of the lesser trochanter of the right hip.

The patient had had scarlet fever, diphtheria, and pneumonia in childhood. She had had two tonsillectomies and a fracture of the right wrist. Her father had died of pneumonia at the age of thirty-one and her mother had died of cardiorenal disease at forty-nine. There were no siblings.

Examination showed that the patient was in

excellent condition. She walked without assistance and without a limp. The length and circumference of the lower extremities were equal. The range of motion of both hip joints was free and normal. Locking could not be elicited by manipulation. On the internal aspect of the right thigh, just below the groin, there was an area of slight tenderness to pressure, and a sense of resistance was palpable, rather than a distinct mass. The remainder of the examination was negative.

Roentgenographic examination showed a large osteochondroma occupying the region of the lesser trochanter and extending upward and inward toward the hip joint.

At operation on December 4, 1935, a six-inch incision was made over the anterior aspect of the right thigh. The sartorius was retracted medially and the tensor fasciae femoris was retracted laterally, exposing the underlying rectus femoris. The fibers of this muscle were split longitudinally and, after some little effort, the anterior aspect of the femur was brought into view. This was cleared subperiosteally, exposing the region of the lesser trochanter. Here was found a large mass, three and five-tenths centimeters in vertical diameter, extending inward and upward from the inner aspect of the shaft of the femur. This mass was very irregular and really consisted of two parts,—an anterior bony and a posterior cartilaginous portion. Between these two masses there was a deep groove, and overlying this was a long aponeurotic fibrous cord, about five-tenths of a centimeter in diameter, extending from the region of the iliopsoas above to the inner lip of the linea aspera below. This cord was very tense and evidently its dislodgement into the groove on the anterior aspect of the tumor was the cause of the locking. This aponeurotic cord was cut, giving easier access to the bony mass. With a chisel, the exostosis was split vertically at its junction with the femur. The exostosis was removed with considerable difficulty because its posterior aspect was adherent to the surrounding periosteum and muscle.

FIG. 2

The excised tumor, showing the groove in which locking was produced.

The postoperative course was essentially uneventful. The wound healed *per primum* and the patient was up and walking on the twelfth postoperative day. She has since been well and has had no recurrence of symptoms.

BILATERAL GIANT MENISCUS

A Case Report

BY MAURICE H. HERZMARK, M.D., NEW YORK, N. Y.

Since there have been only a few cases of a similar nature recorded in the literature, the following case of bilateral giant meniscus is reported.

M. L., a white male, aged fifteen years, was admitted to the Hospital for Joint Diseases on the Service of Dr. S. Kleinberg on July 5, 1932, with a history of pain and clicking of the left knee. The onset of this condition had occurred about two and one-half months prior to admission, with no trauma.

On admission, the patient walked without a limp, but motion of the left knee caused a clicking sound. There was slight pain on pressure over the external line of the joint, and a palpable mass presented on flexion of the joint. The right knee joint showed a similar but less marked condition. Roentgenographic examination revealed no pathology.

On July 8, 1932, under general anaesthesia, and with the use of an Esmarch bandage, the left knee joint was opened through an external parapatellar incision. The external semilunar cartilage covered the entire outer tuberosity of the tibia and extended into the fatty tissue in front and laterally. The entire cartilage was removed, together with a part of the fat pad. The joint was closed in the usual manner and immobilized.

FIG. 1

External semilunar cartilage, showing discoid appearance rather than normal semilunar shape. The ridges are caused by the clamp.

The gross specimen consisted of external semilunar cartilage with part of the capsule and a small piece of the fat pad. The cartilage was gigantic, measuring two and seventy-five hundredths centimeters in width and four centimeters in diameter.

Microscopic section showed a very large semilunar cartilage. There had been some degeneration, causing the tissue to stain poorly and to separate into strands. The synovia had undergone villous hypertrophy and vascularization.

The patient made an uneventful recovery with relief from pain and clicking in the knee which was operated upon.

On October 9, 1935, this patient was readmitted to the Hospital for Joint Diseases because of a clicking on motion of the right knee. Examination on admission showed no limp but a distinct clicking on flexion of the right knee, and a palpable mass over the external semilunar cartilage. The left knee was free from pain or clicking. Because of the experience with the left knee a diagnosis of giant meniscus could now be made.

On October 10, 1935, an arthrotomy, similar to that done on the left knee, was performed on the right knee joint. A very large external cartilage was seen covering the entire external tuberosity of the tibia. There was no marginal thickening, the cartilage being continuous with the transverse ligament. This cartilage was removed *in toto*.

FIG. 2

Microscopic appearance, showing the degeneration and fibrous nature of the tissue.

The gross specimen consisted of a large external semilunar cartilage, three and five-tenths centimeters by three centimeters.

Microscopic section showed mucoid degeneration and young cartilage cells in shreds.

The patient made an uneventful recovery with complete relief from symptoms.

HANDY BONE-GRASPING FORCEPS

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

From the Department of Surgery, Glen Lake Sanatorium, Oak Terrace, Minnesota, and the University of Minnesota, Minneapolis, Minnesota

In the carrying out of thoracoplasties of various types, it has been found desirable at times to have bone-grasping forceps with which to hold firmly ribs which are being stripped from a densely infiltrated or adherent periosteal bed. On other occasions in orthopaedic work, such as holding an Albee graft for shaping, the usual Ferguson lion-jaw bone-grasping forceps have not proved adequate, nor have the large Kocher forceps been capable of holding the graft without springing or permitting the graft to slip. As a result, the bone-grasping forceps shown in Figure 1 (left) were designed by the author and produced in the machine shop at Glen Lake Sanatorium.

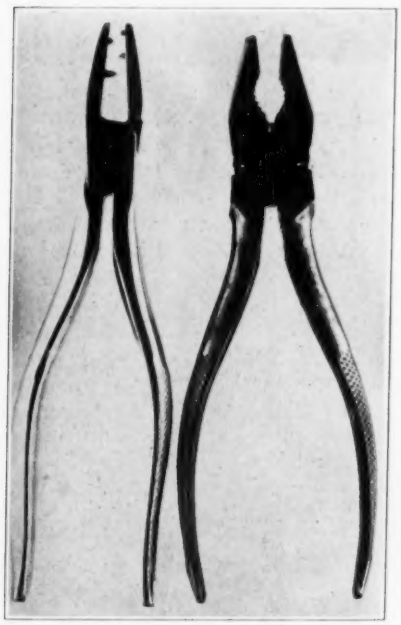

FIG. 1

Broad-nosed heavy-duty pliers, shown in Figure 1 (right), were ground down on an emery wheel, so that the head and nose of the pliers took on the shape shown on the left side of the photograph. The shape of the handles was changed by forging, and several small teeth were set into the jaws as illustrated. Two teeth were placed toward the extremity of one jaw and the other teeth were set in the other jaw nearer the center. The teeth vary in length to allow the firm grasp of even a very thin rib when the forceps are closed. The pins or teeth were made from small twist drills and were forced into drill holes in the jaws of the forceps, after which they were sharpened with a file.

These forceps have been found extremely useful in handling ribs and bone grafts which were either too small to be held securely by the Ferguson lion-jaw forceps or too large to be held firmly by the large Kocher forceps. They have the added advantage over the Ferguson lion-jaw forceps of possessing a rather slender nose, so that they can be used in close quarters.

This instrument can be constructed by a capable machinist at a relatively small cost and, after being plated, makes a valuable addition to the orthopaedic surgeon's equipment.

The author is indebted to Mr. Allen Dean for his technical assistance in constructing this instrument.

AN INSTRUMENT TO AID IN THE REDUCTION OF BENNETT FRACTURES

BY OTHO C. HUDSON, M.D., F.A.C.S., HEMPSTEAD, NEW YORK

The difficulty of obtaining reduction in Bennett's fractures, and of maintaining reduction if it is obtained, prompted the development of this instrument. The illustration shows a glorified towel clip which has since been perfected and has a removable box lock.

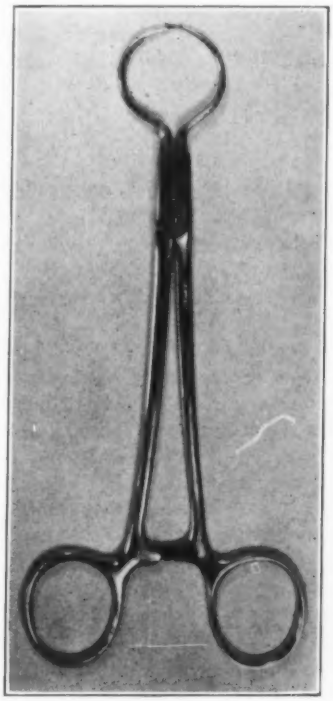

FIG. 1

FIG. 2

The instrument is inserted through the skin into the head of the metacarpal bone with the tongs. After this has been done, traction and abduction are easily obtained by means of skeletal traction, so that anatomical reduction is the rule and not the exception. Plaster is then applied from the tip of the thumb to the elbow, maintaining the thumb in complete abduction and the wrist in slight dorsiflexion. The plaster extends through the web of the thumb to the metacarpophalangeal joint of the forefinger, in order to maintain the abduction.

This instrument has been used in twelve cases, in each of which perfect reduction has been maintained.

SAMUEL R. CUNNINGHAM

Dr. Samuel R. Cunningham, a member of the American Orthopaedic Association since 1932, died at a hospital in Oklahoma City on September 7, at the age of sixty-four. He had done important work in orthopaedic and industrial surgery for many years.

Dr. Cunningham was born on a farm in Putnam County, Indiana, July 20, 1872. He received his professional training at the Medical College of Indiana at Indianapolis, receiving his medical degree from that institution in 1899. He remained in Indianapolis for the next ten years, serving as a member of the faculty of the school from which he was graduated.

In 1909 he moved to Oklahoma City, where he lived and practised until the time of his death. During the last ten years he was Professor of Orthopaedic Surgery in the University of Oklahoma. He was also Orthopaedic Surgeon at St. Anthony's Hospital, Chief of the Orthopaedic Staff of the University Hospital, and Chief of the Orthopaedic Staff of the Crippled Children's Hospital.

In addition to his membership in the American Orthopaedic Association he also held membership in the Oklahoma County Medical Society, the Oklahoma State Medical Association, and the American Medical Association. He was a Fellow of the American College of Surgeons and of the American Academy of Orthopaedic Surgeons.

During his residence in Indianapolis, he attended James Whitcomb Riley. This experience led to an interesting incident on the occasion of the visit of the American Orthopaedic Association to the British Orthopaedic Association in England in 1929. At a dinner given in Liverpool by Sir Robert Jones, Dr. Cunningham recited James Whitcomb Riley's poem "The Little Cripple", to the great delight of Sir Robert.

Dr. Cunningham was a loyal supporter of the American Orthopaedic Association and his friends will always remember his genial spirit at the meetings and his efforts to make them a success. Although far from well, he went by plane to Milwaukee in order that he might attend the Annual Meeting of the Association last May.

He is survived by his wife, Mrs. Della H. Cunningham, and by two sons by a former marriage, one of whom, Hugh, is a surgeon in New York City. Dr. John Cunningham of Indianapolis is a brother.

Funeral services were conducted in Oklahoma City on September 10, with Dr. W. K. West representing the American Orthopaedic Association.

News Notes

Readers of *The Journal*, who have appreciated the valuable contributions of **Dr. Max Böhm** published in the pages of *The Journal*, will be sorry to hear of his death in Berlin on April 26, 1936.

Dr. Böhm was born in Ratibor on December 17, 1878. He received his orthopaedic education in the mechanotherapeutic institution of the University of Berlin, the Massachusetts General Hospital, Boston, Harvard University, and in Hoffa's Clinic in Berlin. He early showed peculiar scientific ability and inclination with a preference for etiological research.

This research work resulted in a long series of valuable articles which set forth through painstaking and detailed anatomical studies the development of human limbs and joints and sought to explain the origin of deformities on the basis of this development. Perhaps particularly worthy of note are the works which deal with the varieties in the structure of the vertebral column, published early in his scientific career. To his experience during the War we owe a number of valuable publications dealing with the subject of prostheses.

While he was connected with the Massachusetts General Hospital he installed and taught the use of the Zander apparatus.

From 1925 until 1933 he was Director of *Krüppelfürsorgestelle* (Institution for the Care of Cripples) in Charlottenburg.

Dr. Böhm was a member of the Deutsche Orthopädische Gesellschaft and was also elected Honorary Member of the British Orthopaedic Association in 1933.

The Annual Meeting of the **British Orthopaedic Association** will be held in London on October 30 and 31, 1936, under the presidency of Mr. W. R. Bristow.

Walter P. Blount, M.D., and Robert P. Montgomery, M.D., announce their association in the practice of bone and joint surgery, with offices at 324 East Wisconsin Avenue, Milwaukee, Wisconsin.

The Congress of Railway Surgeons will meet in their Forty-Seventh Annual Convention at the Palmer House, Chicago, November 5 to 7. Many associations of railway surgeons participate in this Annual Convention.

In recognition of his long and remarkable service to orthopaedic surgery and of his devotion to the work of ameliorating the condition of the crippled child, Prof. Henry Turner of Leningrad has just been honored by the Soviet Government by being made a member of the Military Order of the Red Star. His many friends will be glad to know of this testimonial, which is so well deserved.

At a meeting of the **American Board of Orthopaedic Surgery**, held at Kansas City in May, sixty candidates were examined and Certificates were granted to forty-six. The next examination by the Board will be held at Cleveland on January 9, 1937, just preceding the meeting of the American Academy of Orthopaedic Surgeons. Applicat ons should be sent to the Secretary, Fremont A. Chandler, M D., 180 North Michigan Avenue, Chicago, Illinois.

The Sixty-Fifth Annual Meeting of the **American Public Health Association** will be held in New Orleans, Louisiana, October 20 to 23. An interesting and constructive program, dealing with many phases of public health, has been arranged. Additional information may be obtained from the Association's office, 50 West 50th Street, New York City.

The Fifth Annual Convention of **The American Academy of Orthopaedic Surgeons** will be held in Cleveland, Ohio, January 10 to 14 inclusive, 1937, with headquarters at the Hotel Cleveland.

The program will include scientific papers, seminars, scientific exhibits, and technical exhibits. There will be some distinguished foreign members present.

Some of the outstanding presentations will include seminars on: "The Lesions of the Shoulder Joint", by Dr. E. A. Codman; "Low-Back Lesions", by Dr. Joel Goldthwait; and "Osteomyelitis", by Dr. H. Winnett Orr. Dr. Howard Lewis, a guest, will present a paper on "Sulphur Metabolism in Relationship to Arthritis". Dr. Charles Huggins of the University of Chicago will present a paper on "Red Bone Marrow", and Dr. H. Wingate Todd, on "Normal Bone Growth". There will be a symposium on "Tuberculosis of Bones and Joints", including the following papers: "The Location of the Original Lesion", to be presented by Dr. Dallas Phemister; "Pott's Disease", by Dr. Edwin F. Cave; and "Roentgenology", by Dr. A. B. Ferguson.

REPORT OF THE CONGRESS OF THE LIGUE INTERNATIONALE CONTRE LE RHUMATISME

LUND AND STOCKHOLM, SEPTEMBER 3 to 8, 1936

The Congress opened in the auditorium of the University of Lund. Prof. Sven Ingvar, President of the Congress, welcomed the members to Lund. Dr. R. Fortescue Fox of London, President of the *Ligue*, and Dr. J. van Breemen, the Secretary, spoke of the objects of the *Ligue* and of the Congress. Greetings were given by representatives of Sweden, Russia, France, Germany, Hungary, and the United States. The program of this Congress, under the extremely expert management of Dr. G. Kahlmeter (Stockholm), was divided into four subjects.

I. Allergy in Rheumatic Diseases

Among a few of those reporting were: Prof. Klinge (Münster), Prof. Konchalovski (Moscow), Dr. Freeman (London), Dr. Weil (Paris), Dr. Dawson (New York), Prof. Pletreur (Moscow).

Although infection was considered the probable cause of rheumatism, many believed that the theory of allergy furnishes a basis for a scientific conception of rheumatism, because humoral modifications may result, which play the part in the blood of partial antigens and which may, because of acquired or inherited sensibility, call into being certain pathological anatomical irregularities in organs and joints.

The hypothesis of allergy does not explain the etiological factor, but it has increased our knowledge of the pathogenesis. Up to the present, the allergic nature of rheumatism has not been proved. Our present knowledge makes us assume that it is probable that specific rheumatism is of bacterial origin, but that during the course of the disease allergic reactions play an important rôle.

II. The Reading of X-Ray Photographs in Arthritis

Dr. Scott (London), Dr. Hellmar (Lund), Dr. Vontz (Bad Neuenahr), Dr. Weil (Paris), and Dr. Blaveck (Praha) were among the speakers.

More careful roentgenographic study of rheumatism was considered imperative for differential diagnosis, not only between other diseases (Paget's disease, cancer, gout, etc.), but especially between the different types of arthritis. X-rays alone probably cannot give the etiological factors or the prognosis, but standardized x-rays, preferably serial roentgenograms of the hand, give very accurate data. The general opinion

seemed to be that ankylosing spondylitis began very early in the sacro-iliac joints; according to Scott this was due to infection, and in turn acted as a focus of infection. It occurred before any symptoms brought the patient to the doctor. The opinion was general that more careful observation of the x-rays was needed to distinguish the early changes in bone; this might help us to understand the pathology better.

The opinion was expressed that x-ray treatment, as advised by Dr. Kahlmeter (Stockholm), was of definite benefit in inflamed joints.

III. The Nature of Myalgia

Prof. Ingvar (Lund), Dr. Freund (Wien), Dr. de Pap (Budapest), and Dr. Burt (Bath) spoke.

Myalgia is apparently neither a true neuritis nor neuralgia, but is a pain reaction due to inflammation in the muscles. It is caused by fatigue, cold, moisture, atmospheric pressure, acute or chronic strain, trauma, infections, disturbed metabolism, and physically depressive factors in a supersensitive person. Usually there is an inherited predisposition.

There are three main symptoms: pain, muscular contraction, and palpable infiltration or nodules. The blood circulation is disturbed in all cases, resulting in temperature changes which can be measured. This gives the indication for treatment to restore circulation. The causes of this change may be toxic and bacterial poisons. General factors determine the time for the appearance of symptoms. Localizing factors may escape notice because of their insignificance.

IV. The Help the Orthopaedic Surgeon Can Give in the Treatment of Chronic Arthritis

Prof. Haglund (Stockholm), Dr. Swaim (Boston), Prof. Kahlmeter and Prof. Hybbinthe (Stockholm), Dr. Horvath (Budapest), Dr. Weissenbach (Paris), and Dr. Kersley (Bath).

There was general agreement that orthopaedic care was necessary in the very beginning of rheumatism. Complete rest in plaster was essential to the prevention of deformities and to reduce the inflammation in the joints. The dangers of ankylosis were decreased by early protection.

General posture was important for the relief of joint strain and return to physical vitality. Manipulation was not encouraging, but reconstructive operations were indicated only when the disease was quiescent. Capsuloplasties, synovectomies, arthrotomies, and arthoplasties were the operations of choice.

The cooperation between the medical and orthopaedic departments of the hospital at the beginning of the disease in every case was urged.

Sunday, September 6, was a day of sightseeing and on Monday, September 7, the Congress continued in Stockholm, where still another subject was considered.

V. The Housing Conditions in Rheumatism

Careful studies of the housing conditions in England and Sweden suggest very strongly that, although rheumatic fever, Still's disease, and arthritis are probably infectious in origin, the damp, cold houses, especially along rivers and in wet regions, tend to increase the difficulties in getting well, and chronic conditions result. A dry, well-drained soil seems best for recovery.

Hospital treatment in Sweden has shown encouraging results. The new Lund Hospital affords an excellent example of the Invalid Insurance System, which guarantees expert care to all patients at the minimum of expense to them. The equipment is of the latest and the hospitals are the property of the community, which pays part of the expense of each patient.

The Congress was well attended. Approximately 200 of the leading "Arthrologists" from most of the countries of the world took part in the discussions.

The *Ligue Internationale contre le Rhumatisme* is to be congratulated on its excellent program and the valuable work it is doing in promoting interest in and study of all forms of rheumatism.

Loring T. Swaim, M.D., Boston, Massachusetts

Current Literature

TUMORS OF BONE. (Including the Jaws and Joints.) By Charles F. Geschickter, M.D., and Murray M. Copeland, M.D. With Forewords by Dean Lewis, M.D., and the late Joseph Colt Bloodgood, M.D. Revised Edition. New York, *The American Journal of Cancer*, 1936. 832 pages. $6.00.

A revised, second edition of this text, first issued in 1931, has been necessitated by progress in the knowledge of osseous tumors in the past five years and the desirability of making the work more complete by the addition of three sections on specialized tumors in tendon sheaths, bursae, joints, and the jaws and cranial bones. Also there have been additions to the section on bone diseases other than tumors.

The illustrations are excellent and are better than those of the first edition, and several skeletal charts are included which are made to show graphically the common localization of the various tumors throughout the body.

Coming as it does from the Laboratory of Surgical Pathology at Johns Hopkins University, made famous by the work of the late Dr. Joseph Colt Bloodgood who wrote a foreword, itself an important part of the book, its value as an authoritative statement of present-day knowledge of tumors of bone is practically guaranteed. Clearly written, well documented, and carefully arranged and indexed, it is adapted to the practitioner's needs as well as to the needs of those more particularly concerned with the pathology of this type of disease.

The keynote of the authors' approach to their subject is the endeavor to demonstrate the relationship of osseous tumor formation to osteogenesis. For the most part, it is at the periods of transition from one stage in bone formation to another that the various types of osseous tumor arise. Viewed from this standpoint, the study of osteogenetic tumors is vastly more interesting than before this clue to their investigation was discovered. This knowledge divides the field of osteogenetic tumors into two main divisions, *viz.:* Part I includes those lesions derived from precartilaginous connective tissue and those which are the result of growth subsequent to chondrification. A second class, Part II, embraces tumors of non-osseous origin,—*e.g.*, (1) primary lymphoma of bone, (2) multiple myeloma, (3) metastatic carcinoma, and (4) fibrosarcoma and neurogenic sarcoma. Following the extended consideration of the above classes is a discussion of osseous changes in the hemopoietic system, among which are the granulomata, lymphosarcomata, leukemias, and the rarer diseases of Gaucher, Christian, and Niemann-Pick.

Part III, which is entirely new in this edition, is devoted to tumors of the cranium, the jaws, the synovial membranes, tendon sheaths, and bursae, and is a very valuable supplement to the consideration of the subject of bone and joint pathology.

The final three chapters, constituting Part IV, are devoted to differential diagnosis, juvenile lesions in bone, and a brief but suggestive chapter dealing with therapeutic measures and the fields in which they are applicable.

No one interested in the pathology of bone or the clinical manifestations to which such pathology is related should be without this book.

DIE WIRBELGELENKE (The Intervertebral Articulations). By Prof. Dr. Max Lange. 2 Aufl. Stuttgart, Ferdinand Enke, 1936. 10 marks.

This monograph, dealing solely with the intervertebral articulations, opens another door to the exact diagnosis of many puzzling orthopaedic problems. Schmorl and Junghanns, to whom we are indebted for much of our knowledge of special pathology, indicated the need for this study in their volume "The Normal and Pathological Spine

in the Roentgenogram". There they wrote: "Extensive research must be undertaken before even a degree of clarity can be imparted to our knowledge of the intervertebral joints." This research has been done by Max Lange with the thoroughness typical of the Munich Orthopaedic Clinic.

The first chapter describes the appearance of the normal intervertebral joints and the x-ray technique used. The oblique views are all-important. In the lumbar region, less distortion occurs if the lordosis is corrected by flexing the hips. Reproductions of roentgenograms are given, showing the change in the appearance of the joints during flexion, extension, and lateral bending.

The major portion of the book treats of the pathological joint changes in such conditions as scoliosis, kyphosis, tuberculous spondylitis, arthrosis deformans, vertebral fractures, spondylolisthesis, and "lumbago". As material the author had access to the Schmorl collection of spines and to several thousand roentgenograms of the Munich Clinic. Of the many interesting facts brought out by this study, the following are among the more significant:

1. There is no relationship between the changes in the bodies of the vertebrae (spondylosis deformans) and changes in the intervertebral articulations (arthrosis deformans).

2. Vertebral fractures with compression of the bodies cause definite changes in the intervertebral articulations, and these changes, with compression of the adjacent nerve foramina, are probably responsible for the persistence of pain in the unreduced fractures of the spine.

3. Spondylarthritis ankylopoetica is a rare disease, only twelve cases having been discovered in the Munich Clinic in recent years.

4. Pathological changes in the lumbosacral articulations were found frequently in young as well as in older individuals and are unquestionably one of the important causes of low-back pain.

The book is illustrated with excellent reproductions of roentgenograms. It is a volume which will appeal to all physicians eager to understand more about the causes of back pain.

THE OPERATIONS OF SURGERY. By R. P. Rowlands and Philip Turner. Ed. 8. Volume I. The Upper Extremity, the Head and Neck, the Thorax, the Lower Extremity, and the Vertebral Column. Baltimore, William Wood & Co., 1936. 1045 pages. $10.00.

Rowlands died before this new edition was finished. It was completed by Turner with the assistance of Messrs. Ogilvie, Massie, Thompson, and Gibberd. This system of surgery has been developing since 1889, when it was started by Jacobson. All of the best parts have been retained and augmented, the obsolete have been eliminated, and much of the new surgery has been added.

The examination and preparation of the patient is considered first. There is a general discussion of factors of importance,—the preparation of the patient, the selection of the anaesthetic, the position of the patient on the table, methods of combating shock, and postoperative complications. The usual methods of transfusion, infusion, and skin-grafting are reviewed.

This volume should be of especial interest to the orthopaedic surgeon. Hundreds of pages are devoted to operative treatment of the spine and of the extremities. Many methods of accomplishing a result are given, with emphasis on the method which seems to be the best. Many of the operations are illustrated.

The abstractor was unable to detect the omission of any important operation on these regions. The scope of the book is wide. The treatment of the subjects is concise and interesting, and the subjects have been brought up to date. If the other volumes keep up to this same standard, the entire treatise will be one of the best in surgical literature.

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GELENKKRANKHEITEN (Roentgenographic Diagnosis of Bone and Joint Diseases). By Prof. Dr. Robert Kienböck. Heft 4. Degenerative Wirbelsaulenerkrankungen (Degenerative Lesions of the Spine). Berlin and Vienna, Urban & Schwarzenberg, 1936. 24 marks.

The fourth volume of the series, a little more bulky than the preceding ones, is made up largely of 120 case reports with reproductions of roentgenograms. The degenerative lesions of the spine are grouped as: (1) adolescent kyphosis (Scheuermann); (2) deforming spondylarthrosis, the hypertrophic changes of advancing age; and (3) porotic kyphosis, usually only the local manifestation of a generalized osteoporosis. The condition last mentioned may appear in childhood with the development of poor posture or even severe kyphoscoliosis. Under the second group are discussed lumbosacral pain, spondylolisthesis, and hemangioma. The grouping is rather arbitrary.

There is much interesting and valuable material in this volume. The lack of captions for the illustrations and the absence of any index make it rather inaccessible.

ORTHOPAEDIC SURGERY. By Walter Mercer, M.B., Ch.B., F.R.C.S. (Edin.). With a Foreword by John Fraser, M.C., M.D., Ch.M., F.R.C.S. (Edin.). Ed. 2. Baltimore, William Wood & Co., 1936. $10.00.

Up-to-date textbooks of orthopaedic surgery in English are not numerous and this second edition of Mercer's will probably be well received. Its 906 pages include excellent descriptions of orthopaedic disabilities, both rare and common. The treatment of fractures and other traumatic injuries to muscles, bones, and joints has been omitted. There is, however, a good chapter entitled "Some Complications of Trauma" in which is discussed Volkmann's contracture, myositis ossificans, delayed union, malunion, and non-union.

The subject matter is presented in a clear, orderly fashion and the illustrations are numerous and valuable. As a descriptive text, the book is equal or superior to most of its contemporaries. The author has attempted to bring the treatment of the various orthopaedic disabilities up to date by reviewing the recent literature of the field and incorporating the newer methods which he considers valuable. American contributions receive a good deal of attention. In many places, the author has freely stated his preferences as to method of treatment, thus avoiding the dry, impersonal, judicious presentation of other texts.

The author's point of view, as Fraser states in the foreword, is that of the general surgeon who is particularly interested in orthopaedics. Students and general practitioners will find this a readable, practical reference work though the specialist in orthopaedic surgery will probably not agree with the author on various points of treatment.

MINOR SURGERY. By Frederick Christopher, S.B., M.D., F.A.C.S. With a Foreword by Allen B. Kanavel, M.D., F.A.C.S. Ed. 3. 1030 pages with 709 illustrations. Philadelphia and London, W. B. Saunders Co., 1936. $10.00.

In this third edition the old sections have been amplified and brought up to date. The chief additions are on fracture healing, cleansing of wounds, antiseptics, snake bites, treatment of burns, electric shock, varicose veins, head injuries, compression fractures of the spine, acromioclavicular separation, pilonidal sinus, blood transfusions, and the treatment of ileus.

New material deals with new methods for promoting wound healing, bacteriophage, resuscitation upon the operating table, de Takats' method of ambulatory vein ligation, effort thrombosis, leech treatment of phlebitis, x-ray treatment of gas gangrene, bismuth injection treatment of warts, sodium morrhuate in cystic hygroma, "sprinter's fracture", lymphogranuloma inguinale, Elliott's treatment of pelvic inflammatory disease, torus fractures, glomus tumors, iliopectineal bursitis, Leriche's treatment of sprains, aspiration biopsy, Wangansteen stomach-suction apparatus, etc.

It is surprising how large is the field of "Minor Surgery". However, the author has carefully avoided more than the brief mention of the major surgical procedures. The subjects which he has selected are those usually treated in a physician's office or in a clinic.

One of the best chapters is that on "The Surgical Intern". This could well be read by all interns as well as by the fully qualified surgeon. Much is taught the intern in regard to the care of the patient before, during, and after both minor and major operations.

This is one of the most complete as well as up-to-date books on minor surgery that has been published. It is thoroughly recommended to all surgeons.

VASCULAR DISORDERS OF THE LIMBS. By Sir Thomas Lewis, C.B.C., F.R.S., M.D., D.Sc., L.L.D., F.R.C.P. (London). New York, The Macmillan Company, 1936. $2.00.

This volume is the ninth of a series by the same author on the heart and blood vessels and is directly supplementary to his monographs on "Diseases of the Heart" and "The Blood Vessels of the Human Skin and Their Responses". It is based upon his clinical research and that of his colleagues in the University College Hospital, London, during the past nine years, within which time notable progress has been made throughout the world in the knowledge of disorders of the peripheral circulation.

Although this advance has included important contributions to the understanding and treatment of phlebitis, varicose veins, and aneurysm, the author has excluded these three principal topics from his present consideration, because their inclusion, as the most familiar of the vascular disorders, would unduly increase the size of his book and distract attention from the more important considerations which he has to bring forward. He describes the functions and control of the circulation in the extremities and the methods by which the blood-flow rate, the vascular capacity, and the vasomotor nerves may be tested. He describes the effects of circulatory arrest, both temporary and permanent, and the anatomical phenomena of collateral circulation following the occlusion of the main arteries. In a series of chapters he describes the symptoms, course, and treatment of embolism and thrombosis of the main arteries; of post-ischaemic contractures; of intermittent claudication; of arteriosclerosis; of thromboangiitis obliterans; of local arterial spasm in ergot poisoning, impact, disuse, and cold; of Raynaud's disease; of gangrene associated with cervical rib; of vasodilatation; and of vascular disorders in diseases of the nervous system.

All these conditions are described for practitioners and students, the book being essentially clinical in its purpose. Clearly, these vascular phenomena are matters of interest and importance to the orthopaedist since their presence may complicate or even simulate various orthopaedic conditions which come under his consideration. The book is brief and extremely well written and readable, though without illustrations.

ZUR ERKENNUNG UND BEGUTACHTUNG VON SCHÄDELGRUNDBRÜCHEN. By Hans Hellner. (Heft 19 zur *Monatsschrift für Unfallheilkunde.*) Berlin, Julius Springer, 1935. 4.40 marks.

This work is an analysis of 109 fractures of the base of the skull. Of this series of cases 100 survived the injury, and it is largely this group which the author discusses. Attention is called to the various subjective and objective findings and also to the roentgenographic evidence of injury. These features are analyzed from the diagnostic and prognostic standpoints. Photographic and roentgenographic illustrations are helpful in supplementing the discussions. Numerous case reports are also included to emphasize the importance of different features.

The *Journal* wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Untersuchungen über Splenomegale Leberzirrhosen, sog. thrombophlebitische Milztumoren und chronisch Infektiöse Milzvergrösserungen. Unter besonderer Berücksichtigung der Pathogenese und der Behandlungsresultate bei Splenektomie. Rudolf Brandberg. *Acta Chirurgica Scandinavica*, LXXVII, Supplementum XL. Lund, 1935.

On the Disturbance of the Circulation in Spinal Anaesthesia. An Experimental Study. Oscar O. Schuberth. *Acta Chirurgica Scandinavica*, LXXVIII, Supplementum XLIII. Stockholm, P. A. Norstedt & Söner, 1936.

Contributions au diagnostic des pancréatites chirurgicales. Torsten M. Beckman. *Acta Chirurgica Scandinavica*, LXXVIII, Supplementum XLIV. Stockholm, Bokförlags Aktiebolaget Thule, 1936.

Anales; Revista mensual de Medicina, Cirugía y Especialidades (Valencia), III, Núm. 28, 1936.

Anales de Cirugía (Rosario), II, Nos. 1, 2, 1936.

*Behandlung der Verletzungen und Eiterungen an Fingern und Hand. 2 Aufl. M. zur Verth. Berlin, Julius Springer, 1936.

Corpos extranhos de esophago e bronchios extrahidos na Clinica Oto-Laryngo-Ophthalmologica de Assistencia Municipal do Rio de Janeiro, desde 1932. A. Caiado de Castro. *Boletim da Secretaria Geral de Saude e Assistencia*, No. 3, Supplemento. Rio de Janeiro, 1936.

Boletines de la Sociedad de Cirugía de Rosario, III, Nos. 1–3, 1936.

Bulletin of the National Tuberculosis Association, XXII, Nos. 7–9, 1936.

The Child (Washington, D. C.), I, Nos. 1, 2, 1936.

Cleveland Clinic Quarterly, III, No. 3, 1936.

Current Medicine (Los Angeles), III, Nos. 2, 6, 9, 1936.

*Disability Evaluation. Principles of Treatment of Compensable Injuries. Earl D. McBride, M.D., F.A.C.S. Philadelphia, J. B. Lippincott Company, 1936.

Estudio estadístico del Servicio de Urgencia del Hospital de San Juan de Dios, en los años de 1933 y 1934. Eduardo Perilla Alvarado. Republica de Colombia, Universidad Nacional, Facultad de Medicina. Bogotá, 1935.

The Forum of Osteopathy (Chicago), X, No. 5, 1936.

Hospital for Joint Diseases of the City of New York, Twenty-Ninth Annual Report, for the Year 1935. New York, 1936.

The Johns Hopkins University, School of Hygiene and Public Health, Announcements for 1936–1937. Baltimore, 1936.

Radiography and Clinical Photography (Rochester, N. Y.), XII, Nos. 1, 2, 1936.

Revue Médicale Française (Paris), XVII, No. 6, 1936.

The Rotarian (Chicago), XLVII, No. 5, 1935; XLVIII, No. 1, 1936; XLIX, No. 3, 1936.

Programm des 58. Fortbildungskursus der Wiener medizinischen Fakultät. Internationalen Fortbildungskurs über Fortschritte der Medizin mit besonderer Berücksichtigung der Therapie, Landärztekursus. Vienna, 1936.

Verzeichnis der Ärztekurse im Studienjahre 1936/1937. Das Kursbüro der Wiener Medizinischen Fakultät. Vienna, 1936.

CHONDROMALACIA PATELLAE. Axel Øwre. *Acta Chirurg. Scandinavica*, LXXVII, Supplementum XLI, 1936.

In order to study the pathological and clinical manifestations of chrondromalacia patellae, the knees of 124 subjects were examined at autopsy, and those of 400 persons were examined clinically. The appearance of oedema, of fibrillation, of fraying, and of erosion was tabulated in detail for various age groups. The changes usually began at the distal end of the medial facet of the patella and were noted in surprisingly young individu-

* To be reviewed in a later issue.

als. In older subjects, this location was often the site of the most pronounced degeneration.

In twenty-three cases in which the clinical findings were checked by post-mortem examinations, capsular tenderness at the medial side of the patella and pain on rubbing the patella against the medial femoral condyle were not present clinically without definite degenerative changes. Crepitation on passive movement was suggestive but not definite evidence of cartilage changes. Many of the cases of effusion of unrecognized etiology seemed to be caused by chondromalacia patellae. Transient locking with unusual movements was quite characteristic.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

EIN KASUISTISCHER BEITRAG ZUR BELEUCHTUNG DER MELORHEOSTOSE (Melorheostosis. A Case Report). H. Støren. *Acta Chirurg. Scandinavica*, LXXVIII, 94, 1936.

To the thirteen cases of melorheostosis recorded in the literature there is added another, that of a thirteen-year-old girl. Only the right lower extremity was involved. It was six centimeters shorter than the left and smaller, with knock-knee and valgus of the foot. Roentgenographic examination showed sclerotic areas in the lateral half of the distal femoral epiphysis, in both fibular epiphyses, and in the calcaneum, the cuboid, the cuneiforms, and the metatarsals. There was marked rarefaction of the surrounding bone. The right fibula was relatively shorter than the right tibia and thicker than the left fibula. Growth of the lateral half of the right distal femoral epiphysis was retarded.

There was an associated congenital displacement of the right fourth toe, so that it lay on the dorsum of the third, with plantar prominence of the third and fourth metatarsal heads. This deformity may support Zimmer's theory that melorheostosis is due to disturbances in the formation and development of a protosegment.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ÜBER DIE HEILUNGSRESULTATE DER UNTERSCHENKELDIAPHYSENFRAKTUREN. EINE KLINISCHE UNTERSUCHUNG AN 389 VERSICHERUNGSFÄLLEN AUS FÜNF GROSSEN SCHWEDISCHEN KRANKENHÄUSERN. (The End Results in Diaphyseal Fractures of the Leg. A Clinical Investigation of 389 Insurance Cases from Five Large Swedish Hospitals.) Alf Lundgren. *Acta Chirurg. Scandinavica*, LXXVIII, Supplementum XLII, 1936.

In a monograph including the exhaustive study of 389 cases of fractures of the bones of the leg, taken from five of the largest hospitals in Sweden, the painstaking tabulation of all conceivable statistics was possible because the writer studied not only the insurance reports but the hospital case records as well. In 40 per cent. of the former, there were found to be inaccuracies of diagnosis. Removal from the statistics of all but fractures of the shaft increased the average period of total disability to seventeen months,—five and one-half for simple fractures and eleven and one-half for compound fractures. Other reports from the literature are quoted in which the inclusion of fractures of the ends of the bones considerably lowers these figures. The average age of thirty-eight years was higher than shown in most statistics.

The material furnished a means of comparing the methods of treatment. Half of the simple fractures were reduced and immobilized in plaster. Another fourth required no reduction. On the remainder, fifty-eight open reductions were performed, and extension was used in twenty-two cases. The compound fractures were treated by débridement and primary suture in most cases.

The anatomical position was of considerable significance in determining (1) the duration of temporary disability and (2) the percentage of cases showing permanent disability. The figures were as follows:

	Temporary Disability	*Permanent Disability*
Good anatomical position	130 days	4.0 per cent.
Moderately good anatomical position	200 days	28.3 per cent.
Poor anatomical position	339 days	76.9 per cent.

In addition to two cases among the amputations and five which were operated upon, there was only one case of permanent non-union.

The simple transverse fractures took longer to unite than did the oblique, while the comminuted fractures followed a less favorable course than either of these as to healing period and permanent disability. In the oblique fractures the final results after open reduction were somewhat better than following closed reduction. In compound fractures, however, the results were better from débridement, closure, and wire traction or plaster than from internal fixation.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

DIE SESAMBEINE DES I. METATARSOPHALANGEALGELENKS DES MENSCHEN. EINE RÖNTGENOLOGISCHE, KLINISCHE UND PATHOLOGISCH-HISTOLOGISCHE STUDIE. (The Sesamoid Bones of the Human First Metatarsophalangeal Joint. A Clinical, X-Ray, and Histopathological Study.) Yngve Kewenter. *Acta Orthop. Scandinavica.* Supplementum II, 1936.

More than 100 pages devoted exclusively to the sesamoid bones of the first metatarsophalangeal joint might seem too detailed. Dr. Kewenter has condensed and arranged the material so beautifully, however, that it is readily accessible and easily assimilated. He deals briefly with the rather inadequate literature covering this subject.

Dorsal plantar, axial, lateral, and occasionally plantar dorsal roentgenograms were taken in each of 800 cases. Additional studies were made of 465 children and of autopsy material. The results are clearly tabulated and illustrated by roentgenograms.

A chapter is devoted to a study of the ossification of these sesamoids. Another deals with the position, shape, size, and division of the sesamoids of the great-toe joint. The last chapter describes the pathological changes in the sesamoids with microscopic studies of autopsy material.

The average age of ossification of these sesamoids in boys is eleven years as opposed to nine in girls. Ossification may proceed from one or more centers. Multiple centers most frequently occur in the medial sesamoid. Once having begun, ossification proceeds rapidly to completion in one or two years. The medial sesamoid is larger and lies farther distal than the lateral in most cases.

Divided sesamoids occur much more frequently than is suggested in the earlier literature. In this series 33.5 per cent. of the patients had this condition. It is more frequent in the medial than in the lateral sesamoid.

There are lesions, but no characteristic ones, of the sesamoids of the first metatarsophalangeal joint. They may occur without the appearance of symptoms. In the collected material, fractures both of the undivided and of the divided sesamoids were observed. The changes of arthrosis deformans occurred in about 10 per cent. of the cases.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

BIOLOGICAL BASIS OF SURGERY, PARTICULARLY ORTHOPEDIC SURGERY. George W. Hawley. *Am. J. Surg.*, XXXI, 438, March 1936.

This article, written on a subject little understood and by a surgeon of great experience, should be read in detail by every surgeon desiring a deeper insight into the relation of anatomy, physiology, and pathology to form, function, and tissue changes incident to disease and trauma.

"When surgical problems are approached from the basis of anatomy function or abnormal form and function, only one side of a polygonal problem is seen. Anatomy represents an existing standard of form, without appreciation of the processes producing it and those ceaselessly at work to effect change of form.

"The same applies to physiology and pathology; representing existing phenomena of normal and pathological functions.

"The combination of anatomy, physiology, pathology, including their offspring, physiological chemistry, bacteriology and their many first and second cousins; the careful weighing, assaying and grouping of all these is not enough to complete the picture. Their

composite grouping and fusion does not make human biology, biological factors, processes and laws as applied to the human organism.

"Biology is defined as, 'the science of life or living organisms,' but to make the definition inclusive would be to paint a picture of all living things, both vegetable and animal. For convenience biology may be divided into three divisions, plant, mammalian and human. Human biology might be defined as a combination of all those factors, processes and potential forces which are continuously working in the human organisms to regulate and determine both function and form in normal and abnormal states, from intrauterine birth through the period of growth, adult activity and decline.

"When an approach is made to a surgical problem the operator should have in mind the biological factors as well as the anatomical, the physiological and the pathological. In order to pattern surgical relief in accordance with the biological laws of purpose and design, he should make the following inquiries: (1) the biological processes which are at work, (2) what structures are involuting and which evoluting, (3) which are potentially weak and more frequently damaged and which are strong, (4) what attack is best suited to one in contrast to the other, (5) what is the relationship of form to function and the process which produced the form, (6) what are the processes of defense and repair, (7) what is the particular relationship of deformity to disability, (8) what are the processes affecting adjustment of function to deformity. Methods of surgical relief have been automatically guided and controlled to accord with biological laws, but not always do methods fit these laws. Success and failure have helped to show the way, for the history has been groping and stumbling in the dark to find the way. The man who first opened an abscess made a great discovery, but he was unaware of the full meaning. He discovered a biological process the importance of which did not become apparent until Lister exposed it to the light."—*Custis Lee Hall, M.D., Washington, D. C.*

ROTARY DISLOCATION OF ATLAS ON AXIS. J. O. Rankin. *Am. J. Surg.*, XXXII, 27, Apr. 1936.

The author adds nine new cases of this dislocation, which he believes is more frequent than is generally indicated. The mechanism is usually a mild force or twisting of the head with a resulting tear of the capsular ligament and dislocation of one of the atlantal facets. Symptoms are severe pain in one or in both sides of the neck and inability to rotate the head, with tilting of the head toward the dislocated side. Palpation reveals the spinous process of the axis on the opposite side of the midline toward the side to which the chin is rotated, and straightening the head increases the deviation of the axial spine from the midline. Satisfactory roentgenograms are often difficult to obtain, because of the position which pain causes the patient to assume. In eight of the cases reduction was by means of the jury-mast. Open reduction is difficult and rarely necessary. Casts were applied and retained for from five to eight weeks. In cases where manipulation is used the Walton method is preferred.—*Custis Lee Hall, M.D., Washington, D. C.*

TREATMENT OF SPRAINS BY INTERLIGAMENTARY INJECTION OF NOVOCAINE. René Leriche and G. Arnulf. *Am. J. Surg.*, XXXII, 45, Apr. 1936.

The authors advocate local injections of novocain into the ligaments of joints which are the seats of injuries or postoperative strains. They believe that a sprain is the reflex consequence of trauma, and specifically is the result of a distortion of the nervous apparatus present in the articular ligaments. The technique is injection of ten to twenty cubic centimeters, according to the importance of the articulation, of a 1-per-cent. solution of novocain into the region of the traumatized ligament at the spot of maximum tenderness. Care should be taken to inject the ligament itself. In the case of the hip, a long flexible needle is carried to the femoral neck and withdrawn about one centimeter, and the injection is then made. In this manner more rapid and complete restoration of function can be obtained. Best results are obtained in cases of simple sprain with articu-

lar impotency and the after-effects of sprain, such as pain and muscular atrophy, and in cases of operative sprain of ligaments following orthopaedic operations or manipulations.—*Custis Lee Hall, M.D., Washington, D. C.*

FRACTURES OF THE SHAFT AND NECK OF THE FEMUR. REPORT OF 119 CASES. Irwin E. Siris and C. J. Delaney. *Am. J. Surg.*, XXXII, 277, May 1936.

During the past fifteen years, there have been ten cases of fracture of the neck of the femur in the Children's Surgical Service, Bellevue Hospital; six of these were reported by Colonna. Two cases were treated by the authors with Russell traction, and the other two by the Whitman method. Three cases of fracture of the shafts of both femora were treated by the Russell method with good results.

One hundred and nineteen children with fracture of the femur were treated in five years,—thirty, by a modification of Bryant's overhead suspension; fifteen, by reduction on the Hawley table, skin traction, and a plaster spica; and seventy-two, by the Russell method. Except in cases of children under four, where Bryant's method was used, the Russell method was used in all cases as a routine, with uniformly satisfactory results. The Thomas splint was used by the ambulance surgeons in all cases. There was no residual shortening in 109 of the 115 cases of fracture of the shaft of the femur. The authors use a modified apparatus which holds the leg in abduction and internal rotation.—*Custis Lee Hall, M.D., Washington, D. C.*

CALCIFIED DEPOSITS IN SUBSCAPULARIS TENDON. C. E. Thompson and C. W. McLaughlin, Jr. *Am. J. Surg.*, XXXII, 524, June 1936.

The tendon of the supraspinatus muscle is much more frequently involved than are the tendons of the infraspinatus and teres minor muscles in cases of painful lesions of the shoulder. Causative factors are acute and chronic trauma to the shoulder and occupational strains, especially when the arm is used in the abducted position; also, focal infections and abnormalities of calcium metabolism are predisposing factors. Codman reported two cases of subscapular tendonitis in a group of 152 calcified lesions of tendons in painful shoulders. The authors suggest that in roentgenographic studies of the painful shoulder the lesion may be overlooked in the two usual views of the shoulder unless the lesser tuberosity is visualized. One case is reported in detail, in which treatment by open operation and removal of the involved calcified area gave a good result. Attention is called to the spontaneous disappearance of the deposit in many cases, with or without treatment. Economic factors enter into many cases, and operative procedure gives more prompt relief and a shorter period of disability.—*Custis Lee Hall, M.D., Washington, D. C.*

BCG VACCINATION IN WESTERN EUROPE. G. Gregory Kayne. *Am. Rev. Tuberc.*, XXXIV, 10, July 1936.

BCG is harmless. As an adjunct to other methods of prophylaxis, it produces a very partial immunity under certain conditions. Where the tuberculosis mortality is high, the economic conditions poor, and dispensaries and sanatoria inadequate, BCG clearly appears to offer a simple method of prevention. It is essential that the vaccine should be prepared *on the spot*, for the age of the culture has a direct bearing upon the attenuation and virulence. The indications for its use must depend upon the amount of tuberculosis and the extent of the antituberculosis organization in each country.—*Clarence A. Ryan, M.D., C.M., Vancouver, B. C., Canada.*

IL POTERE RIGENERATIVO DEI MENISCHI IN RAPPORTO ALLA TERAPIA (RICERCHE SPERIMENTALI). (The Regenerative Power of the Semilunar Cartilages in Relation to Therapy.) Giovanni Bazzocchi. *Ann. Italiani di Chir.*, XIV, 1237, 1935.

In carrying on this experimental work, the author removed the internal semilunar cartilages of rabbits. There was no postoperative immobilization. Perfect regeneration of the meniscus followed in all cases in which there was no infection.

The regenerated semilunar cartilage shows its highest structural differentiation after

approximately 100 days. At gross inspection and also microscopically, it is almost normal. The regeneration takes place from a fold of capsular tissue which extends between the two joint ends. Starting as simple fibrous tissue, it gradually undergoes structural changes with transformation to cartilage. The cartilage cells are at first very numerous, but gradually they get more scarce and become isolated. The collagenous fibers increase; elastic fibers appear late. Vessels are seen at first, but they gradually disappear with more mature structural differentiation of the meniscus. In man, regeneration of the semilunar cartilage is never as advanced as in animals. It remains more fibrous than cartilaginous. In lesions of the semilunar cartilages early and complete removal of the injured meniscus is the treatment of choice. Incomplete removal involves the danger of degenerative arthritic changes of the joint ends. Even after a lapse of five months following the removal of the semilunar cartilages, animals do not show arthritic changes.—*Ernst Freund, M.D., Venice, Florida.*

TUBERCULOUS DISEASE OF BONE. M. M. Cruickshank. *The Antiseptic*, XXXIII, 129, March 1936.

The author discusses the forms and treatment of bone tuberculosis in cases observed on his Service at the Medical College in Madras. He outlines the clinical course of tuberculosis in the long bones; in the short bones, such as the phalanges; in the vertebrae; and in less frequent sites, such as the clavicle, the sternum, the ribs, and the flat bones of the skull. He recognizes three clinical pathological varieties,—the localized forms, the spreading forms, and the atrophic form. He points out that there may also be a fourth, the hypertrophic form, which, however, is likely to be complicated with syphilis, especially in the Oriental races.—*Robert M. Green, M.D., Boston, Massachusetts.*

ERYTHROCYTE SEDIMENTATION RATE IN RHEUMATOID ARTHRITIS AND ALLIED CONDITIONS. Govind Lal Sharma. *The Antiseptic*, XXXIII, 355, June 1936.

From the Department of Pathology in the University of Lucknow, the writer presents the results of his laboratory studies in the erythrocyte sedimentation rate in rheumatoid arthritis and in allied conditions. After observing this rate in a series of pathological conditions compared with a group of normal controls, the author concludes that, although the sedimentation rate is a non-specific reaction, it is definitely prolonged in atrophic infective rheumatoid arthritis and in hypertrophic degenerative osteo-arthritis, and can, therefore, render definite diagnostic service in the recognition of these two important varieties of chronic joint disease.—*Robert M. Green, M.D., Boston, Massachusetts.*

L'ARTROTENODESI TIBIO-PERONEO-ASTRAGALICA NEI POSTUMI DELLA PARALISI INFANTILE (Arthrotenodesis of the Ankle Joint Following Infantile Paralysis). Carlo Re. *Arch. di. Ortop.*, LI, 675, 1935.

The author reports 150 cases of poliomyelitis in which arthrodesis of the ankle joint was performed, together with tenodesis of the foot extensors. He emphasizes the necessity of observing carefully the indication for this operation. It is worthless in the case of an entirely flat foot or in that of a foot with markedly reduced muscle power. It aims at correction of foot deformity and at stabilization. In short-equinus deformity or in cases with some varus of the heel, the operation permits better correction than does subastragaloid arthrodesis.—*Ernst Freund, M.D., Venice, Florida.*

ARTRODESI E TRAPIANTO CONTEMPORANEO NELLA PARALISI DELLA SPALLA (Arthrodesis and Muscle Transplantation in Paralysis of the Shoulder). Andrea Albanese. *Arch. di Ortop.*, LI, 763, 1935.

In cases of paralysis of the shoulder, Albanese has worked out a method by which one may obtain at the same time good intra-articular arthrodesis, solid extra-articular bony union, and transplantation of the upper portion of the trapezius to the upper end of the humerus. Through a posterior incision, the lateral half of the spina scapulae is removed, together with the insertion of the trapezius. The joint is opened and all of the

cartilage is removed. A small groove is chiseled in the upper end of the humerus behind the greater tuberosity. The spina scapulae is rotated for about 190 degrees and firmly pushed into the groove in the humerus. This rotation tightens the fibers of the trapezius muscle. The wound is closed, and the arm is immobilized in 80 degrees of abduction and 25 to 30 degrees of forward flexion. After three months of immobilization, functional reeducation is possible in a special brace which permits rotation of the scapula.—*Ernst Freund, M.D., Venice, Florida.*

ESPERIENZE SULL'IMPIEGO DI MATERIALE DI SUTURA IMPERMEABILIZZATI NELLA CHIRURGIA DELLE OSSA (Experiences in Bone Surgery with Suture Material Rendered Impermeable). Andrea Albanese and Felice Parravicini. *Arch. di Ortop.*, LII, 5, March 1936.

A short historical review on osteosynthesis is followed by the report of numerous experiments with different absorbable materials which had been rendered impermeable,—silk impregnated with rubber, chromic catgut, and linen prepared with cellulose. Such material remains preserved for a very long time, even when passed through the bone. Roentgenographic follow-up showed the material up to nine months after application. Specimens taken after this period and investigated anatomically still exhibited a good mechanical resistance,—silk impregnated with rubber showed the least deterioration, while chromic catgut had almost entirely disappeared. Impregnated silk gave the least tissue reaction, and the use of chromic catgut led to irregular periosteal reaction.—*Ernst Freund, M.D., Venice, Florida.*

SU UN CASO DI EMANGIOMA MUSCALARE PRIMITIVO DELLA GAMBA (A Case of Primary Hemangioma in the Muscles of the Leg). Luigi Imperati. *Arch. di Ortop.*, LII, 79, March 1936.

The author discusses in a general way hemangioma in the muscles of the lower extremity and gives a review of the cases reported in the literature. Careful analysis reveals that not all of the cases reported can be classified as primary hemangiomata. A case of cavernous hemangioma in the gastrocnemius muscle is reported, including the pathological study. The treatment of choice is surgical removal. If the tumor is too extensive, amputation may be indicated.—*Ernst Freund, M.D., Venice, Florida.*

GINOCCHIO RECURVATO ANCHILOTICO CONSECUTIVO AD ARTRITE PIOGENA POST-TRAUMATICA (Genu Recurvatum with Ankylosis Following Pyogenic Post-Traumatic Arthritis). Antonio Poli. *Arch. di Ortop.*, LII, 167, March 1936.

The author reports a case of severe genu recurvatum with bony ankylosis of eleven years' duration in a seventeen-year old boy. A wedge resection was performed with excellent results. The analysis of the different factors contributing to the deformity reveals (1) weight-bearing and the action of the quadriceps muscle, and (2) uneven growth due to partial destruction of the epiphyseal plate.—*Ernst Freund, M.D., Venice, Florida.*

RÔLE OF THE RETICULO-ENDOTHELIAL SYSTEM IN THE DEPOSITION OF COLLOIDAL AND PARTICULATE MATTER IN ARTICULAR CAVITIES. John G. Kuhns and Harold L. Weatherford. *Arch. Surg.*, XXXIII, 68, July 1936.

In a logical series of experiments, the authors studied the deposition in joints of colloidal and particulate matter that had been introduced into the body through the gastro-intestinal tract and by subcutaneous injection. They assumed that this foreign matter was carried through the blood stream and they showed that it was stored in the joints, chiefly in the elements of the reticulo-endothelial system. Using rats as their experimental animals, they determined the amount of deposition of this particulate matter in the normal joint and then compared this with the findings in the joints that had been altered by direct injury, by irritative injection, or by the enforced rest induced by

paralysis. In another experiment the local blocking of the reticulo-endothelial system was attempted.

Their studies indicate that mild inflammation in the joint tends to increase the amount of deposition of particulate matter and that local blocking of the reticulo-endothelial system is only transitory in its prevention of the deposition of such matter in the joint tissues. From these experiments, the authors are careful not to make any unwarranted application to the therapy of articular diseases.—*I. William Nachlas, M.D., Baltimore, Maryland.*

Etiology of Deep Acetabulum and Intrapelvic Protrusion. A. M. Rechtman. *Arch. Surg.*, XXXIII, 122, July 1936.

Rechtman presents five cases of bilateral congenitally deep acetabulum and intrapelvic protrusion of the acetabulum, and surveys the literature and previous case reports on this condition. It is his belief that the intrapelvic protrusion is produced by the superimposition of functional stress, infection, or injury on an acetabulum that previously has been abnormally deep. The depth of the socket is attributed to an overgrowth of the iliac and ischiopubic segments of the hip, coupled with an excessive development of the acetabular rim. It is suggested that heredity may play a factor in the anatomical abnormality.—*I. William Nachlas, M.D., Baltimore, Maryland.*

Effects of Circulatory Disturbances on the Structure and Healing of Bone. Injuries of the Head of the Femur in Young Rabbits. Gene H. Kistler. *Arch. Surg.*, XXXIII, 225, Aug. 1936.

The upper end of the femur, including the trochanteric region and the neck and the head of the femur, receives nutrition through several circulatory channels. Experimental studies in rabbits indicate the importance of the blood supply entering the epiphyses from the capsular attachment in the hip joint. The vessels of the ligamentum teres are also important. When either of these sources of circulation is destroyed, the other supply develops to compensate for the loss. On the other hand, injury to the metaphyseal vessels of the neck produces relatively little change in the head. There is little connection between the circulation of the shaft and that of the neck and head, with the cartilage plate acting as a fairly sharp line of demarcation.

These facts play an important rôle in the healing of fractures of the neck of the femur. In rabbits there is a definite delay in the repair of a fracture when either of the chief sources of circulation is impaired. If the fragments are placed in proper position, healing can, however, take place, chiefly through revascularization coming from the capsular attachment at the base of the neck.

The studies are all based on growing rabbits, and the author calls attention to the fact that one must observe caution in applying these observations to man.—*I. William Nachlas, M.D., Baltimore, Maryland.*

Congenital Dislocation of the Head of the Radius. Bryan McFarland. *British J. Surg.*, XXIV, 41, July 1936.

By means of roentgenograms and photographs an interesting study of eleven instances of this rare condition is presented. The appearances of the radial head and of the proximal end of the ulna are quite unlike those seen in traumatic dislocation of the head. Function was interfered with in five patients and operation was undertaken. Removal of the head is recommended when function is interfered with.

A knowledge of this congenital condition is important because of possible medico-legal complications in an accident case.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Spondylolisthesis. James A. Jenkins. *British J. Surg.*, XXIV, 80, July 1936.

One case is cited in which an abdominal approach was made to the body of the fifth lumbar vertebra. With a bone drill, five-twelfths of an inch in diameter, a hole was made

through the body of the fifth lumbar vertebra into the anterior aspect of the first sacral segment for a distance of two inches. A bone graft from the tibia was driven into this hole so that it fitted tightly.

A year later the patient's deformity was largely corrected. He could walk without difficulty or pain.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE SIGNIFICANCE OF LUMBOSACRAL TRANSITIONAL VERTEBRAE. G. A. G. Mitchell. *British J. Surg.*, XXIV, 147, July 1936.

This article contains a careful study of the anatomical variations in the lumbar spine and sacrum in the higher primates, with the changes resulting from man's assuming the erect position. Sacralization of the fifth lumbar vertebra or lumbarization of the first sacral vertebra may produce painful symptoms. These are produced (1) by impingement of the transverse process on the sacrum or lateral bending, (2) in unilateral cases, by this impingement acting as a fulcrum for the spinal column, which then acts as a lever to separate the vertebra from the sacrum and to tear ligaments, (3) by the formation of a bursa, (4) by peri-arthritic changes, and (5) by stretching of the fourth lumbar nerve.

Conservative treatment is advised, but operation must be considered if the patient is not relieved.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THREE CASES OF FRACTURE RESULTING FROM ELECTRIC SHOCK. H. Jackson Burrows. *British J. Surg.*, XXIV, 159, July 1936.

Three instances of fracture of the upper end of the humerus, occurring as a result of a non-fatal electric shock, are cited.

The first patient was a barber who received a shock while handling a vibro-massage machine. The next day he complained of severe pain in his shoulder. Nine weeks later a roentgenogram showed a crush fracture of the head of the humerus.

In the second case, the injury was from a shock by an electric kettle, followed by a fall. It was not certain whether or not the fall contributed to the avulsion and fracture of the greater tuberosity of the humerus, which roentgenographic examination revealed.

In the third instance, the patient fell against a water tank while carrying an electric lamp. Roentgenograms showed an impression fracture of the humeral head opposite the glenoid.

It is suggested that the fractures were caused by the violent, uncontrolled contraction of the shoulder muscles. The question is raised whether the passage of the current through the bones was a factor.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

OSTEOCHONDRITIS DEFORMANS COXAE JUVENILIS OR PERTHES' DISEASE: THE RESULTS OF TREATMENT BY TRACTION IN RECUMBENCY. Arthur L. Eyre-Brook. *British J. Surg.*, XXIV, 166, July 1936.

The various theories in regard to the etiology of Perthes' disease are discussed. There are five early signs: (1) increased density of the epiphysis, (2) increased depth and clarity of the joint space, (3) early flattening of the epiphysis, (4) early metaphyseal cavitation, and (5) Courtney Cage's sign. The late signs are: (1) flattening and further condensation of the epiphysis, (2) broadening of the neck of the femur, (3) confluent cavitation of the metaphysis, (4) partial collapse of the "cavited" metaphysis, (5) regeneration of the more or less deformed epiphysis, (6) condensation of the regenerated epiphysis, (7) sometimes partial disappearance of the epiphyseal line in its outer portion, (8) the appearance of the transverse cervical line, and (9) adaptive acetabular changes.

The author believes that traction in recumbency is the ideal treatment for children under seven years of age, or for patients over this age if in an early stage of the disease. Sliding traction with weight and pulley or Pugh's extension are the methods used. The end results are shown by excellent roentgenographic reproductions. The results obtained are believed to be permanent.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

ADHESIONS OF JOINTS AND INJURY. R. Watson Jones. *British Med. J.*, I, 925, May 9, 1936.

The author states that the conditions under which adhesions form around joints constitute one of the fundamental problems of fracture treatment. It is a problem which is frequently misunderstood.

Joint stiffness after injury is due to adhesion of the capsular plications, which, in turn, is the result of organization of any exudate in the periarticular tissues. In fact, it is the recurrence and persistence of serofibrinous exudation which provides the key to the problem of adhesion formation. Frequently the source of the exudate is extra-articular, as the joint itself is normal.

The following factors, several of which may occur in the same case, are considered responsible for continued or recurrent exudation: (1) disuse with continued venous stasis, (2) recurrent oedema, (3) the recurrent trauma of daily passive stretching or repeated manipulation, (4) the constant trauma of immobilization in a position of strain, (5) continued infection near a joint, and (6) the continued irritation of foreign bodies near a joint.

Immobilization in itself is not a major factor in the development of adhesions when uncomplicated by other factors. Any adhesions formed are the result of venous stasis. Once a patient resumes active use of the part, recovery of normal function occurs.

The author emphasizes the serious disability that follows the presence of continued oedema in a limb which is immobilized. "There is no more potent factor in adhesion formation, for oedema is the glue of which adhesions are made." Swelling is controlled by external pressure and active muscle exercise.

The author particularly denounces passive stretching and exercise, since such therapy results in a continual recurrent traumatic exudation, with the formation of fresh adhesions.

Under the heading "Foreign Bodies Near Joints," the use of skeletal traction near joints is condemned particularly, because where the foreign body (pin or wire) penetrates the skin there is the possibility of a low-grade infection. This infection may be of minimal degree and may show no external signs, but it is the cause of continued exudation in neighboring tissues, and hence of adhesions which are much more resistant than the adhesions of simple immobility. Again, in contrast to fracture experience in this country, the author states that the factors noted account for the frequency of permanent stiffness of joints when articular fractures are treated with wires and screws. For example, he believes that olecranon fractures treated by internal wire fixation usually exhibit permanent limitation of extension movement, because the wire is associated with a low-grade inflammatory reaction, and the resultant irritative serofibrinous exudation gives rise to periarticular adhesions which are particularly resistant.—*G. E. Haggart, M.D., Boston, Massachusetts.*

TREATMENT OF TUBERCULOSIS OF THE SPINAL COLUMN. M. Grobelski. *Chir. Narz. Ruchu*, IX, 5, 1936.

The author did not notice any distinct results after the use of Friedmann's serum. Calvé's method of treatment of abscesses by paracentesis with special trocars gave negative results. In eighty cases Albee's operation was performed. In 48 per cent. the results were good; in 15 per cent., moderate; and in 15 per cent., unsatisfactory; 22 per cent. of the patients died. The author believes that one should not operate on children before the twelfth or fifteenth year. Albee's graft may be considered as an internal corset which abbreviates the duration of convalescence and stabilizes the results obtained by the preceding conservative treatment.—*Joseph K. Narat, M.D., Chicago, Illinois.*

OSTEOPLASTIC OPERATION ON ACETABULUM AS TREATMENT OF CONGENITAL DISLOCATION OF HIP. Z. Ambros. *Chir. Narz. Ruchu*, IX, 89, 1936.

This method was used in twenty-eight cases. Perfect results were obtained in 18.2 per cent.; good results, in 45.5 per cent.; relatively good, in 18.1 per cent.; and bad results

in 13.6 per cent.; in 4.6 per cent., no check-up was possible.—*Joseph K. Narat, M.D., Chicago, Illinois.*

RESECTION OF THE CLAVICLE FOLLOWED BY ITS REGENERATION. F. Borusiewicz. *Chir. Narz. Ruchu*, IX, 177, 1936.

In the course of a general septicaemia, osteomyelitis of a clavicle developed in a man twenty-one years of age. A subperiosteal resection was followed by rapid recovery. Complete regeneration took place, and the function of the corresponding upper extremity became normal.—*Joseph K. Narat, M.D., Chicago, Illinois.*

FRACTURA DE LA COLUMNA VERTEBRAL. J. I. Mitchell. *Cir. Ortop. y Traumatol.*, III, 207, 1935.

Among fractures of the spine those of the cervical region are most frequently complicated by paralysis. A spinal puncture is indicated in such cases. If the flow of the spinal fluid is blocked by an osseous obstruction, an immediate laminectomy is advisable. If no paralysis is present, or if it has been eliminated by an operation, a hyperextension of the vertebral column is indicated. This can be accomplished by applying Wallace's or Davis' method, or by using Herzmark's adjustable convex frame. Rogers' frame, which is a modification of Bradford's frame, may also be employed. In selected cases the methods described by Dunlop, O'Donohue, or Jones may be considered. The prognosis of fracture of the spine is not as bad as is frequently assumed.—*Joseph K. Narat, M.D., Chicago, Illinois.*

NICOLA'S OPERATION IN RECURRENT DISLOCATIONS OF THE SHOULDER. A. Inclán. *Cir. Ortop. y Traumatol.*, III, 231, 1935.

On revising his own statistics, the author finds that among 4,500 patients 113 were treated for dislocations, twenty-eight of which affected the shoulder. Of these dislocations, eleven were of the recurrent type. Although he recommended surgical intervention to all of these patients, only five followed his advice, and the present paper refers to them. In one case the author employed a modification of his own, by working out a tunnel in the posterior plane of the head of the humerus, to prevent its posterior displacement. He recommends this modification only in case of posterior dislocation. A woman operated on according to this method had an epileptic attack one week after discharge from the hospital. Contrary to previous attacks, this one did not produce a dislocation of the affected shoulder, but the other shoulder became dislocated, proving the severity of the attacks and the success of the operation. The author asserts that, in his opinion, Nicola's method ought to be the procedure of choice. Although he considers that the time which has elapsed since the surgical intervention is too short for claiming conclusive results, he stresses the fact that to date he has not observed any recurrences.—*Joseph K. Narat, M.D., Chicago, Illinois.*

IMPROVED TECHNIQUE OF IMMOBILIZATION WITN THE SMITH-PETERSEN NAIL FOR OSTEOSYNTHESIS OF FRACTURES OF THE FEMORAL NECK. A. Inclán. *Cir. Ortop. y Traumatol.*, IV, 5, 1936.

The author has devised an apparatus which facilitates immobilization with the Smith-Petersen nail in fractures of the femoral neck. This instrument consists of two small hollow rods, through which the Kirschner wires are pushed like the lead of an automatic pencil, and of a transverse piece with three slots,—one in the center for the Smith-Petersen nail, and one on each side to introduce the two rods. After reduction of the fracture according to Leadbetter's method, the limb is kept in abduction of from 30 to 35 degrees and in internal rotation. A vertical incision, three inches long, reaches the lower end of the trochanter. The infratrochanteric fossa is exposed and the center of Poupart's ligament is marked. The anterior fixing rod is introduced along the anterior aspect of the femoral neck in the direction of Poupart's ligament, until it touches the bone. The wire is then inserted. In the same manner the other rod is introduced along the posterior

border of the femoral neck. The external ends of the two rods are slipped through the corresponding slots in the transverse bar, which is pushed to the bottom of the wound until it almost touches the bone. The direction of the bar is from the center of Poupart's ligament to the infratrochanteric fossa. A Smith-Petersen nail is then introduced; a dressing is applied; and a roentgenogram is taken. If the direction of the guiding apparatus and of the nail is correct, the nail is driven into the cephalic fragment, whereupon the parts of the guiding instrument are removed. If the angle of inclination requires some modification, the nail is withdrawn from the cortex and the position is corrected. The wound is closed in the usual manner and the extremity is immobilized in a plaster spica.—*Joseph K. Narat, M.D., Chicago, Illinois.*

Surgical Treatment of Two Cases with Obstetrical Paralysis of Upper Extremities. S. Toledo and J. P. Lorio. *Cir. Ortop. y Traumatol.*, IV, 31, 1936.

The authors present two cases with deformities of the upper extremity produced by obstetrical paralysis. One of them was diagnosed as belonging to the so called mixed or Duchenne-Erb-Klumpke type, while the other was of the superior radicular type. In both cases the arm was kept in a position of abduction and marked internal rotation. The corresponding hand was not able to reach the mouth. One case could be attributed to the use of forceps; no such clue, however, could be found in the other case. Conservative treatment was unsuccessful. The surgical treatment consisted of an osteotomy above the insertion of the deltoid muscle, according to the method suggested by Nové-Josserand. The cosmetic and functional results were satisfactory.—*Joseph K. Narat, M.D., Chicago, Illinois.*

Case of Malunion of Colles' Fracture and Its Orthopaedic Repair. A. B. Inclán. *Cir. Ortop. y Traumatol.*, IV, 63, 1936.

Surgical intervention in cases of Colles' fracture with malunion should aim at the anatomical reconstruction of the articular line of the radius, especially of the bistyloid line, and at the correction of the deformity. The author recommends an osteotomy of the radius at the height of the fracture with restoration of the epiphysis to its correct position and introduction of an osseous wedge at the site of the fracture, in order to lower the styloid process of the radius without using osteosynthetic material. A preliminary ulnar osteotomy is not necessary in adolescents and children on account of favorable anatomical conditions at this age. In adults such a preliminary procedure is unavoidable as it facilitates a proper setting of the radius; otherwise the interposition of the interosseous ligament and the pronator quadratus muscle interferes with reduction of the fragments. An osteotomy of the ulna with removal of a wedge involves the danger of nonunion, as observed in the author's case. Pain, stiffness of the articulation, and weakness after exertion disappeared entirely after the surgical procedure.—*Joseph K. Narat, M.D., Chicago, Illinois.*

Observations on Etiological Factors in Rheumatoid Arthritis. Govind Lal Sharma. *J. Indian Med. Assn.*, V, 535, June 1936.

The author presents a brief study of the etiological factors involved in rheumatoid arthritis. It is his conclusion that the arthritides of constitutional nature, dependent on non-specific, focal infections, are more numerous and even more important than those associated with specific infective agents like the gonococcus or the streptococcus. In his work at Lucknow, he has found this type of arthritis particularly amenable to cure by eradication of focal sepsis and by the employment of vaccine therapy.—*Robert M. Green, M.D., Boston, Massachusetts.*

Congenital Dislocation of the Hip. H. A. T. Fairbank. *Med. Press and Circ.*, CXCII, 7, January 1, 1936.

The author points out several physical signs which help in making a diagnosis of "congenital hip" in infants. Some of these are: apparent inequality of leg length,

asymmetry of gluteal creases or of adductor creases, apparent female type of pelvis, and palpation of the femoral head beneath the femoral artery.

The more common findings, such as the later appearance of the Trendelenburg sign, etc., after walking is begun, are discussed. The x-ray appearances, from the early subluxating stage to the development in old cases of a secondary acetabulum on the wall of the ilium, are also considered.

The treatment advocated by the author is the "bloodless reduction method" until the child is so old that an attempt proves unsuccessful. After this, open reduction is indicated.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE PHYSIOLOGICAL BASIS FOR THE MODERN TREATMENT OF FRACTURES. A. L. d'Abreu. *Med. Press and Circ.*, CXCII, 299, April 1, 1936.

During the last few years there has been a decline in the number of patients with fractures who have been referred to the massage departments; coincidental with this, there has been a marked decrease in the periods of incapacity, with a saving of compensation fees and lost wages.

The healing process of two adjacent fractured bone ends is described and the author explains why excessive motion between these healing fragments prevents union.

The author cites Watson Jones's article on "Non-Union" in substantiation of his own observations and presents further instances in proof of this, all of which is to point out the non-physiological aspects of early passive motions and massage in fracture treatment.

The modern tenets of fracture treatment are:

1. Accurate anatomical reduction;
2. Complete immobilization until sound union has occurred;
3. As full functional activity of the limb as is possible. The further merits of the modern treatment of fractures are discussed, including the psychological effect on the patient, which, in the newer methods, is uniformly good.—*Herbert E. Hipps, M.D., Marlin, Texas.*

ASSOCIATION OF B. COLI INFECTION AND RHEUMATOID ARTHRITIS. Gerald Slot and P. M. Deville. *Med. Press and Circ.*, CXCIII, 4, July 1, 1936.

The obscure etiological factors in rheumatoid arthritis are pointed out. Nine out of twenty-four patients with rheumatoid arthritis were found by the author to have an unsuspected bacilluria. Thinking that this might be a factor of importance in the origin or progress of the disease, these patients were given alkaline medication, with resultant subjective improvement.—*Herbert E. Hipps, M.D., Marlin, Texas.*

GONOCOCCAL ARTHRITIS. John T. Armstrong. *Med. Press and Circ.*, CXCIII, 9, July 1, 1936.

Gonococcal arthritis in a patient having gonorrhoea is often brought on by neglect of proper care, by exposure to cold, by bodily stress, by excessive drink, and by other excesses.

The first essential in treatment is to place the joint at rest and to keep it at rest in such a position that it will be the most useful if stiffness should occur. For example, the knee should be straight; the elbow, flexed with the thumb up; the wrist, in dorsiflexion; the spine, in extension, etc.

When acute symptoms have subsided, active and passive motion is indicated if carefully and gently carried out.

The use of typhoid bacterial injections and different drugs is discussed and their respective merits are evaluated.

Foci of infection in the prostate or the vesicles should be treated by massage, topical applications, and diathermy or by a Belfield operation.—*Herbert E. Hipps, M.D., Marlin, Texas.*

DIE BEHANDLUNG DER PSEUDARTHROSE DES KAHNBEINES DER HAND (Treatment of Pseudarthrosis of the Scaphoid Bone of the Hand). Hans-Heinrich Westermann. *Monatschr. f. Unfallheilk.*, XLIII, 287, June 1936.

For ununited fractures of the carpal scaphoid Westermann recommends a drilling operation rather than the extirpation of the smaller fragment. The operation is performed under local anaesthesia, with a small incision in the anatomical snuff-box. A drill is introduced into the fragments which are visualized by means of the x-ray. After the drill holes have been made, the wound is closed and immobilization in plaster-of-Paris is resorted to for a period of six weeks.—*I. William Nachlas, M.D., Baltimore, Maryland.*

LES RHUMATISMES DE LA CHIMIOTHÉRAPIE (Chemotherapeutic Rheumatism). A. Tzanck, F. Layani, E. Sidi, and H. P. Klotz, *Presse Méd.*, XLIV, 1052, 1936.

The cutaneous, hepatic, and renal accidents of chemotherapy have been studied in detail, but the articular manifestations appear to have been neglected. Study of the literature and of 215 of the authors' own cases led to the conclusion that there is a definite arthropathy associated with chemotherapy. Clinically, the condition is found three times as frequently in women as in men, and it usually attacks young persons between the ages of twenty and forty. The symptoms appear suddenly and at any time in the course of the treatment. The amount of the drug does not appear to influence the onset of symptoms. Most commonly, the affection presents itself as a polyarthralgia, but it may appear as a hydro-arthrosis. More rarely it may accurately simulate acute rheumatic fever, with its polyarticular involvement, sweating, gastro-intestinal upset, etc. Since the Aschoff body is no longer considered as pathognomonic of acute rheumatic fever, the differentiation between the two conditions can be made only on the ground that the patient with a chemical arthropathy never suffers involvement of the cardiac structures.

The arsenical form of arthropathy is usually of the polyarthralgic type and is frequently associated with nitritoid crises. The bismuth form is usually of the non-articular type, develops late, and is associated with stomatitis, etc. Gold, aristol, atophan, bromides, quinine, novocain, the barbiturates, and other chemicals have been reported as giving rise to joint symptoms. The barbituric form, it is to be noted, develops late and tends toward ankylosis and amyotrophy, but may be completely obviated by discontinuance of the drug.

The general characteristics of the group cannot be explained on the basis of infection or toxic reaction. It is the author's opinion that only a disturbance of the sympathetic vasomotor system can adequately explain the diverse manifestations of the chemotherapeutic arthropathies. That form of arthropathy which has been observed to develop ten days after the beginning of medication presents the typical picture of an anaphylactic reaction with the associated skin rashes, etc. In this sense the chemotherapeutic rheumatisms resemble the protein rheumatisms of serum disease, described by Bezançon, Weil, and others. Carrying the argument further, the authors quote Bezançon to the effect that the pseudo-infectious arthropathies observed in scarlet fever, dysentery, and gonococcal infections may be related to the protein and chemical arthropathies. In similar manner, the authors raise the question of the relation of acute rheumatic fever to these previously mentioned arthropathies. They express the opinion that acute rheumatic fever is an infectious disease, due to an unknown specific virus which, however, determines articular reactions resembling those of the protein or chemical types. The consequence of this is that all rheumatisms are differentiated from that type of arthropathy in which the causative organism can be recovered.

This article is extremely interesting and stimulating. It is well worth careful rereading in the original.—*Henry Milch, M.D., New York, N. Y.*

DOUBLE VERTICAL FRACTURE OF PELVIS. CASE REPORT. L. Ramallal. *Rev. Méd.-Soc.*, VI, 169, 1935.

A twenty-eight-year-old miner sustained a double vertical fracture of the pelvis. The posterior fracture line passed through the right side of the sacrum and the anterior

fracture line went through both branches of the left pubic bone; the lower branch was fractured in two places. A shortening of two and five-tenths centimeters resulted. This was responsible for a compensatory lumbar lordosis.—*Joseph K. Narat, M.D., Chicago, Illinois.*

UN CASO DE "PATELLA CUBITI" DOBLE. A. Oller and J. Ruiz Gijón. *Rev. Méd.-Soc.*, VIII, 576, 1935.

In the case reported, large sesamoid bones were present bilaterally in the distal insertion of the triceps muscles of both arms. They resembled the patellae. Such formation may be mistaken for a fracture of the olecranon.—*Joseph K. Narat, M.D., Chicago, Illinois.*

SHEPHERD'S FRACTURE. J. M. S. Bordona. *Rev. Méd.-Soc.*, V, 20, 1936.

The posterior apophyses of the astragalus can be visualized in roentgenograms taken in the lateral direction. There are two such apophyses: internal and external. The first, if separated from the remaining bone, can be mistaken for a tubercle found on the posterior aspect of the astragalus at the point of the insertion of the posterior fibers of the deltoid ligament of the astragalotibial articulation. The external apophysis, which may have a triangular, square, or rectangular shape, is located between the insertions of the posterior astragaloperineal and posterior astragalocalcaneal ligaments. Under normal circumstances, the astragalus forms from one ossification center. Occasionally the embryonic cartilage forms two such centers, from which the astragalus proper and the so called os trigonum develop. A fracture of the postero-external apophysis can easily be mistaken for os trigonum or Shepherd's fracture. Such a fracture may be the result of a violent torsion of the foot or of a direct trauma with the foot in a position of plantar hyperflexion. Hypertrophy of the posterior apophysis is a predisposing factor. In the absence of complicating lesions the prognosis is good. Immobilization for from fifteen to twenty days is necessary.—*Joseph K. Narat, M.D., Chicago, Illinois.*

BEITRAG ZUR OSTEOCHONDRITIS DISSECANS DES HUFTKOPFES (Osteochondritis Dissecans of the Head of the Femur). E. Friedl. *Röntgenpraxis*, VIII, 16, 1936.

Aseptic necrosis of the head of the femur may occur in two different clinical and roentgenographic types: when the necrosis is wide-spread, collapse of the whole bone takes place, with the resultant picture of Perthes' disease; if the necrosis is limited to a small subchondral portion of the head, a piece of necrotic bone sequestrates and osteochondritis dissecans develops. This disease in the hip joint was first described by Haenisch in 1925. Since that time few papers on this subject have been published, but all authors agree on the rare occurrence of the disease. Friedl, however, describes not less than twenty-one cases of osteochondritis dissecans in the hip joint and has found this localization as common as in the knee joint. The free body develops as a rule at the upper pole of the head, the place of greatest weight-bearing; only one case showed the joint mouse coming from the medial lower plane of the head. It is usually oval in shape, from one to three centimeters long and from one-half to one centimeter thick. It is not freely movable and is fixed at the surface by fibrous tissue. Immigration from the bed has not been observed. The further development is either reattachment of the mouse in the defect or complete resorption. This development is chronic and finally the picture of arthrosis deformans appears. The origin is either spontaneous or a secondary injury after hypothryeotic derangement of the growth of the head of the femur, or following reposition of a congenital or traumatic dislocation of the hip joint, slipped epiphysis, or healed fracture of the neck of the femur. Osteochondritis dissecans of the knee, elbow, and hip joints, occasionally combined with Perthes' or Köhler's disease, has been described in the same family.

The preliminary stage is marked by the development of necrosis until the time of demarcation, and is mostly free of clinical and roentgenographic symptoms. The second stage, demarcation of the mouse, occurs with pain on walking and long standing, and with

limitation of motion. In exceptional cases, patients are symptom-free during this stage, as noted by the author in a bilateral case in a man, thirty-five years old, in whom no changes developed during a four-year period of observation.—*Joseph Wolf, M.D., Iowa City, Iowa.*

OSTEOCHONDRITIS DISSECANS AS RELATED TO TRAUMA. Robert V. Funsten and Prentice Kinser. *Southern Med. J.*, XXIX, 262, March 1936.

The authors report a typical case of this disease in the carpal scaphoid, as well as a case in which the lesion was on the palmar surface of the semilunar cartilage. Their series consisted of twenty-three cases and of these only nine were of the classical type. Trauma has generally been accepted as the logical cause of this condition.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

BONE SYPHILIS. J. S. Speed and H. B. Boyd. *Southern Med. J.*, XXIX, 371, Apr. 1936.

Lesions may appear in the primary, secondary, or tertiary stages of the disease. Lesions were found in one-half of one per cent. of the patients admitted to the Campbell Clinic in Memphis. Age incidence, location, pathology, and roentgenographic changes are described. Diagnosis is difficult, and resort to antiluetic treatment is often necessary to distinguish this disease from other conditions. The results of serological tests are variable, especially in adults.

The influence of trauma on bone syphilis is discussed. The authors feel that the influence of syphilis on the healing of fractures has been exaggerated. Most fractures in syphilitics will heal properly if handled correctly.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

RECOGNITION OF THE MODERN TREATMENT OF BROKEN HIPS. Lawson Thornton and Calvin Sandison. *Southern Med. J.*, XXIX, 456, May 1936.

The authors consider fixation of the fractured neck of the femur by a Smith-Petersen nail as the modern treatment. No consideration is given to any other method. For the past two years they have used no other method. All ages and all conditions have been treated by "blind nailing" controlled by roentgenograms in two planes. Uniform success has resulted in their series of thirty-two cases. A description of their technique and method of taking roentgenograms is included.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

REPAIR OF THE LIGAMENTS OF THE KNEE. REPORT OF A NEW OPERATION FOR REPAIR OF THE ANTERIOR CRUCIAL LIGAMENT. Willis C. Campbell. *Surg. Gynec. Obstet.*, LXII, 964, June 1936.

The writer discusses the indications for repair of the knee ligaments and describes the anatomy and mechanism of these ligaments. The most frequent and disabling injuries are those of the internal lateral ligament, the internal semilunar cartilage, and the anterior crucial ligament, either alone or in combination. In the writer's series there was no instance of injury of the external lateral ligament or of the posterior crucial ligament disabling enough to warrant operative measures.

An operative technique for replacement of the anterior crucial ligament is described and clearly illustrated. In brief, it consists of obtaining a strong piece of tendon, fascia, and capsule, one-third of an inch wide by eight inches long, through an incision just mesial to the patella; this is left attached at its distal end, and is then threaded through drill holes in the tibia and femur placed as nearly as possible in the line of the original anterior crucial ligament. The strip is sutured above and lateral to the periosteum and fascia lata, with the knee in 140 degrees of flexion. A posterior splint is applied, with the limb in full extension, and is worn for three weeks; then active and passive motion is started. The incision permits arthrotomy if necessary. Apparently excellent results have been obtained in nine cases.

The advantages of this procedure are "the extreme simplicity, minimum trauma, shorter incisions, and decrease in operating time".—*Richard McGovney, M.D., Santa Barbara, California.*

Über die Knochenstruktur bei Marmorknochenkrankheit (Bone Structure in Marble Bone). Walter Laubmann. *Virchows Arch. f. path. Anat.*, CCXCVI, 23, 1935.

This is a minute description of the histological findings in Albers-Schönberg disease. The appearance is that of maldevelopment derangement of enchondral ossification, and slow apposition of the primary osteoid cells without preceding resorption of the cartilage. A thickened compacta with small osteoblasts is formed only in the diaphyseal region. The spongiosa is dense and forms an "inner compacta". The findings in the epiphyses and in the metaphyses harmonize with those in the short tubular bones. In the diaphysis there is, aside from the formation of primary osteoblasts, a metaplastic chondroid-osteoid development. The bone marrow shows mostly a fibrous degeneration; therefore, anaemia and myeloid metaplasia of the liver, the spleen, and the lymph glands follow.—*Joseph Wolf, M.D., Iowa City, Iowa.*

Zur operativen Behandlung der habituellen Schulterluxation (The Operative Treatment of Habitual Dislocation of the Shoulder). R. Pfeiffer. *Ztschr. f. orthop. Chir.*, LXIII, 205, 1935.

The author recommends a method which, although it gives good results, is little known. This procedure, published simultaneously by Oudard and Noesske in 1924, has as its basic principle the lengthening of the coronoid process. An incision is made between the deltoid and the pectoralis muscles and the cephalic vein is ligated if necessary. This is followed by the free preparation of the coronoid process, including the biceps, the coracobrachialis, and the pectoralis minor muscles. An oblique subperiosteal tunnel is next chiselled outward and downward, and the external fragment is displaced below about one inch. The periosteum is sutured. If necessary the bones are also sutured through several drill holes. The arm is fixed in abduction for from two to three weeks, after which physical therapy is instituted. Among the twelve cases in which the author operated, there was only one redislocation.—*Joseph Wolf, M.D., Iowa City, Iowa.*

Über ein solitäres Xanthom im Knochen (Solitary Xanthoma in Bone). Günther Bahls. *Zentralbl. f. Chir.*, LXIII, 1041, May 1936.

From the literature fifty-seven cases of xanthomatosis have been collected by the author. He has divided them into eight groups:

1. Xanthomatosis with skeletal changes, exophthalmos and diabetes insipidus (complete triad of Christian-Rowland disease);
2. Xanthomatosis with skeletal changes and exophthalmos, but without diabetes insipidus (incomplete triad, type A);
3. Xanthomatosis with skeletal changes and diabetes insipidus, but without exophthalmos (incomplete triad, type B).
4. Xanthomatosis with skeletal changes, but without exophthalmos and diabetes insipidus;
5. Xanthomatosis with diabetes insipidus, but without skeletal changes and exophthalmos;
6. Xanthomatosis with growth disturbances;
7. Xanthomatosis or so called xanthosarcomatosis without skeletal changes and diabetes insipidus;
8. Xanthomatosis of the skin in children and in adults.

In addition to these types the author describes a case of a farmer, twenty-six years of age, who injured his right shoulder with an axe while splitting wood. A swelling developed, which was aspirated several times. Eighteen months after the accident operative removal of the swelling was performed. The pathological finding was spindle-cell sarcoma. Three years later a new swelling appeared in the middle third of the right humerus, about four inches below the old swelling. This new swelling was also removed by operation. The pathological slide showed typical xanthoma cells but no sarcoma cells. A careful examination of the whole skeleton showed no other bone lesion.—*Joseph Wolf, M.D., Iowa City, Iowa.*

INDEX TO VOLUME XVIII

1936

OLD SERIES VOLUME XXXIV

AUTHORS

A

PAGE

Adams, Z. B. The Occurrence of Abscesses from Tuberculous Hips That Are Firmly Ankylosed 974
Aitken, Alexander P. The End Results of the Fractured Distal Tibial Epiphysis .. 685
End Results of Fractures of the Proximal Humeral Epiphysis 1036
Allard, Louis. Surgical Treatment of Sacrocoxalgia 54
Armstrong, Basil, and Jarman, T. Francis. A Method of Dealing with Chronic Osteomyelitis by Saucerization Followed by Skin-Grafting 387

B

Badgley, Carl E., Yglesias, Luis, Perham, W. S., and Snyder, C. H. Study of the End Results in 113 Cases of Septic Hips 1047
Barr, Joseph S., and Buschenfeldt, Karl. Turnbuckle Brace. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. 760
Bauer, Walter, and Bennett, Granville A. Experimental and Pathological Studies in the Degenerative Type of Arthritis 1
Bennett, George E. Old Dislocations of the Shoulder 594
Bennett, Granville A., and Bauer, Walter. Experimental and Pathological Studies in the Degenerative Type of Arthritis 1
Bosworth, Boardman M., and Bosworth, David M. Use of Fascia Lata to Stabilize the Knee in Cases of Ruptured Crucial Ligaments 178
Bosworth, David M. A Hip Brace 238
Osteocamp for Osteotomoclasis 648
An Unusual Shoulder Lesion 1078
Bosworth, David M., and Bosworth, Boardman M. Use of Fascia Lata to Stabilize the Knee in Cases of Ruptured Crucial Ligaments 178
Boyd, H. B., and Speed, J. S. Operative Reconstruction of Malunited Fractures about the Ankle Joint 270
Brogden, W. E. Acute Osteomyelitis of the Scapula (Acromion Process) 795
Review of 100 Cases of Scoliosis Treated by Spine Fusion 1027
Brown, Adolph M. A Method of Immobilizing the Chest 787
Brown, Lloyd T. The Treatment of Club Feet 173
Burbank, Reginald, and Hadjopoulos, L. G. Streptococcic Dissociation in the Pathogenesis of Chronic Rheumatoid Arthritis 19
Buschenfeldt, Karl, and Barr, Joseph S. Turnbuckle Brace. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. 760

C

Calvé, Jacques, and Galland, Marcel. Osteosynthesis in Spinal Tuberculosis. Translated from the French by **Alan H. Todd** 46
Campbell, Willis C. Posterior Dislocation of the Hip with Fracture of the Acetabulum 842
Carr, Francis J., Jr., Krida, Arthur, and Colonna, Paul C. Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for Anterior Distortion 1018
Carrell, W. B. End Results in 100 Fractures Treated by Internal Removable Fixation 408
Cavanaugh, Lyman A., Shelton, E. Kost, and Sutherland, Ross. Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis 957
Cave, Edwin F., and Roberts, Sumner M. A Method for Measuring and Recording Joint Function 455
Chandler, Fremont A. Adjustable Shoulder Strap for Postoperative Torticollis Cast 239
Chipps, H. Davis. A Simple Adhesive Boot for the Prevention of Foot-Drop in Traction-Suspension Procedures 788

PAGE

Chuinard, Eldon G., and **Dillehunt, Richard B.** Melorheostosis Léri. A Case Report ... 991
Colonna, Paul C., Carr, Francis J., Jr., and **Krida, Arthur.** Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for Anterior Distortion ... 1018
Compere, Edward L. Localized Osteitis Fibrosa in the New-Born and Congenital Pseudarthrosis ... 513
Indications for and against the Leg-Lengthening Operation. Use of the Tibial Bone Graft as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture ... 692
Cooperman, Morris B., and **Leventhal, Gottlieb S.** Colon-Bacillus Osteomyelitis ... 242
Couch, J. Harold. Epidermoid Cyst in Bone of Skull ... 475
Cox, Wilbur J. A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation ... 134
Crosby, Edward H. Dislocation of the Elbow Reduced by Means of Traction in Four Directions ... 1077
Cyriax, J. H. The Pathology and Treatment of Tennis Elbow ... 921

D

Delahaye, A. Treatment of Quiescent Tumor Albus and Pseudarthrosis of Tuberculous Origin in Children. Translated from the French by **Alan H. Todd** ... 51
Dellinger, Samuel C., and **Wakefield, Elmer G.** The Probable Adaptation of Utilitarian Implements for Surgical Procedures by the "Mound Builders" of Eastern Arkansas ... 434
Dickson, Frank D. Presidential Address. [American Academy of Orthopaedic Surgeons.] ... 263
Dillehunt, Richard B., and **Chuinard, Eldon G.** Melorheostosis Léri. A Case Report 991
Doane, Clarmont Paul. Fractures of the Supracondylar Process of the Humerus ... 757
Duncan, George A., and **Ferguson, Albert B.** Benign Giant-Cell Tumor of the Fourth Lumbar Vertebra. A Case Report ... 769
Duncan, Wallace S. The Relation of the Prostate Gland to Orthopaedic Problems 101

E

Easton, Edward Raymond. A New Use for the Knickerbocker Tongs. Correction of Diastasis after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type) ... 979
Epstein, Sigmund. Fracture of Ankylosed Extremities ... 529

F

Fahey, John J. The Effect of Lumbar Sympathetic Ganglionectomy on Longitudinal Bone Growth as Determined by the Teleoroentgenographic Method ... 1042
Fahey, John J., and **Siegling, John A.** The Fate of Transplanted Cow's Horn ... 439
Fairchild, Robert D. Acute Hematogenous Osteomyelitis of the Scapula (Acromion Process) ... 232
Fang, H. C., and **Miltner, Leo J.** Prognosis and Treatment of Tuberculosis of the Bones of the Foot ... 287
The Effects of Hypercalcaemia on Joints ... 909
Ferciot, C. Fred, and **Thomson, J. E. M.** A Tautening Bolt for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of Fractures ... 245
Ferguson, Albert B. Roentgenographic Features of Rheumatoid Arthritis ... 297
Ferguson, Albert B., and **Duncan, George A.** Benign Giant-Cell Tumor of the Fourth Lumbar Vertebra. A Case Report ... 769
Ferguson, Albert B., and **Risser, Joseph C.** Scoliosis: Its Prognosis ... 667
Finder, Jerome G. Congenital Anomaly of the Coracoid. Os Coracosternale Vestigiale ... 148
Findlay, Francis M. A Useful Amputation Guard ... 236
Findlay, Robert T. A Traction Sleeve ... 796
Fitzgerald, R. R. Amputation for Sarcoma of the Neck of the Femur by the Interinnomino-Abdominal Method ... 402
Fortner, H. C., Livingston, S. K., and **Kendall, W. E.** Gout: An Unusual Manifestation in a Stump ... 240
Foucar, H. O. A Modification of the Balkan Frame ... 526
Frantz, Charles H. Fractures Occurring after Operation for Osteomyelitis of the Femur, with Ultimate Union ... 969
Freiberg, Joseph A., and **Perlman, Robert.** Pelvic Abscesses Associated with Acute Purulent Infection of the Hip Joint ... 417
Freund, Ernst. Some Considerations on Subtrochanteric Osteotomy and Intra-Articular Arthrodesis of the Hip Joint ... 654

PAGE

Freund, Ernst. Translation from the Italian of: Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the Femur. By **Domenico Logròscino** 671
Funsten, Robert V., and Kinser, Prentice. Fractures and Dislocations about the Shoulder 191

G

Gaenslen, Frederick J. The President's Address. [American Orthopaedic Association.] The Rôle of Physical Therapy in Orthopaedic Surgery 559
Galland, Marcel, and Calvé, Jacques. Osteosynthesis in Spinal Tuberculosis. Translated from the French by **Alan H. Todd** 46
Galland, Walter I. The Ischial Seat Brace. A Substitute for the Thomas Ring Brace 790
Gaynor, Sidney S. Congenital Astragalocalcaneal Fusion 479
A Simple Method for the Ambulatory Correction of Flexion Contracture of the Knee. The Use of Continuous Elastic Tension as the Corrective Force 766
Gill, A. Bruce. An Evaluation of Present-Day Methods of Dealing with Congenital Dislocation of the Hip 487
Gill, A. Bruce, and Stein, Irvin. Bone Metabolism: Its Principles and Its Relations to Orthopaedic Surgery 941
Gold, Aaron M., Sloane, David, and Sloane, Marian Frauenthal. Dyschondroplastic Bow Legs 183
Goldenberg, Raphael R., and Leventhal, Gottlieb S. Supratrochanteric Calcification 205
Griswold, R. A. A Three-Point Hyperextension Back Brace 784

H

Haas, S. L. Study of Fusion of the Spine with Particular Reference to Articular Facets 717
Hadjopoulos, L. G., and Burbank, Reginald. Streptococcic Dissociation in the Pathogenesis of Chronic Rheumatoid Arthritis 19
Hadley, Lee A. Apophyseal Subluxation. Disturbances in and about the Intervertebral Foramen Causing Back Pain 428
Hamsa, W. R. Panastragaloid Arthrodesis. A Study of End Results in Eighty-Five Cases 732
Harris, R. I. Difficulties in the Diagnosis of Bone Tumors 631
Harris, R. I., and McDonald, J. L. The Effect of Lumbar Sympathectomy upon the Growth of Legs Paralyzed by Anterior Poliomyelitis 35
Heath, Arthur L., Schwartz, R. Plato, and Trautmann, Otto. Gait and Muscle Function Recorded by the Electrobasograph 445
Henderson, Melvin S., and Swart, Howard A. Chronic Osteomyelitis Associated with Malignancy 56
Herzmark, Maurice H. Bilateral Giant Meniscus 1082
Hudson, Otho C. An Instrument to Aid in the Reduction of Bennett Fractures . . . 1085
Hudson, Otho C., Robin, Nathaniel H., and Robin, Percival A. Interesting Malignant Bone Tumors 215
Hutchison, Jay L. An Apparatus for Correction of Subluxation of the Tibial Head 510

I

Inge, George A. L. Congenital Absence of the Medial Sesamoid Bone of the Great Toe. Report of Two Cases 188

J

Jahss, S. A. Fractures of the Proximal Phalanges. Alignment and Immobilization 726
Torticollis 1065
Jarman, T. Francis, and Armstrong, Basil. A Method of Dealing with Chronic Osteomyelitis by Saucerization Followed by Skin-Grafting 387
Jeřábek, Vladimír. The Treatment of Surgical Tuberculosis by Vaselin Injections and Closed Plaster-of-Paris Bandages 851
Johnson, Robert W., Jr. Arthritis as a Teaching Problem 865
Jostes, Frederick A. Fracture of the Acetabulum with Central Dislocation of the Head of the Femur. A Method of Treatment 483

K

Kaplan, Emanuel B. Extension Deformities of the Proximal Interphalangeal Joints of the Fingers. An Anatomical Study 781

PAGE

Kendall, W. E., Fortner, H. C., and **Livingston, S. K.** Gout: An Unusual Manifestation in a Stump 240
King, Don. The Function of Semilunar Cartilages 1069
The Healing of Semilunar Cartilages 333
Kinser, Prentice, and **Funsten, Robert V.** Fractures and Dislocations about the Shoulder 191
Krida, Arthur, Colonna, Paul C., and **Carr, Francis J., Jr.** Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for Anterior Distortion 1018
Kulowski, Jacob. Pyogenic Osteomyelitis of the Spine. An Analysis and Discussion of 102 Cases 343

L

Lee, Harold G. Lumbosacral Fusion for the Relief of Low-Back Pain. A Report of Thirty-Five Cases 375
L'Episcopo, J. B. Pathological Dislocation of the Sacro-Iliac Joint 524
Stabilization of Pathological Dislocation of the Hip in Children 737
Leventhal, Gottlieb S., and **Cooperman, Morris B.** Colon-Bacillus Osteomyelitis 242
Leventhal, Gottlieb S., and **Goldenberg, Raphael R.** Supratrochanteric Calcification 205
Levinthal, Daniel H. Old Traumatic Displacement of the Distal Femoral Epiphysis. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur 199
Lieberman, Herman S. Enlarged Intermetatarsophalangeal Bursae of Both Feet. A Case Report 1062
Livingston, S. K. A Guide for the Parham Band 228
The Therapeutic Active Principle of Maggots with a Description of Its Clinical Application in 567 Cases 751
Livingston, S. K., Kendall, W. E., and **Fortner, H. C.** Gout: An Unusual Manifestation in a Stump 240
Logròscino, Domenico. Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the Femur. Translated from the Italian by **Ernst Freund.** 671
Ludlum, Walter D., Jr., and **Ritter, Henry H.** Intratarsal Dislocation. Report of a Case of Anterior Midtarsal Dislocation 773

M

McDonald, J. L., and **Harris, R. I.** The Effect of Lumbar Sympathectomy upon the Growth of Legs Paralyzed by Anterior Poliomyelitis 35
McKeever, Francis M., and **Wilson, John C.** Hematogenous Acute Osteomyelitis in Children 328
McMurray, T. P. Ununited Fractures of the Neck of the Femur 319
Marians, A. A Form of Balanced Traction. A Modification of Russell Traction 234
Mauck, H. Page. A New Operative Procedure for Instability of the Knee 984
Mayer, Leo. Further Studies of Fixed Paralytic Pelvic Obliquity 87
Mayer, Leo, and **Ransohoff, Nicholas.** Reconstruction of the Digital-Tendon Sheath. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons 607
Mensor, Merrill Coleman, and **Parker, Leon O.** Unusual Fractures of the Spine 153
Meyerding, Henry W. Roentgen-Ray Therapy of Bone Tumors 617
Treatment of Benign Giant-Cell Tumors 823
Milch, Henry. Cortical Avulsion Fracture of the Lateral Tibial Condyle 159
Bilateral Recurrent Dislocation of the Ulna at the Elbow 777
Miller, O. L. Surgical Management of Pes Calcaneus 169
Miltner, Leo J., and **Fang, H. C.** Prognosis and Treatment of Tuberculosis of the Bones of the Foot 287
The Effects of Hypercalcaemia on Joints 909
Mitchell, Joseph I. Total Dislocation of the Astragalus 212
Morton, S. A. Localized Hypertrophic Changes in the Cervical Spine with Compression of the Spinal Cord or of Its Roots 893

N

Nachlas, I. William. The Knee-Flexion Test for Pathology in the Lumbosacral and Sacro-Iliac Joints 724
Narat, Joseph K. A New Plaster-of-Paris Cutter 793

O

Ober, Frank R. The Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of Low-Back Disabilities and Sciatica 105

P

PAGE

Palew, Philip. An Inexpensive Portable Therapeutic Pool 247
Parker, Leon O., and **Mensor, Merrill Coleman.** Unusual Fractures of the Spine.. 153
Patton, Edwin F. A Pelvic-Band Leg Brace with Two-Way Motion at the Hip . 794
Peabody, Charles W. Hemihypertrophy and Hemiatrophy. Congenital Total Unilateral Somatic Asymmetry 466
Perham, W. S., Snyder, C. H., Badgley, Carl E., and **Yglesias, Luis.** Study of the End Results in 113 Cases of Septic Hips 1047
Perlman, Robert, and **Freiberg, Joseph A.** Pelvic Abscesses Associated with Acute Purulent Infection of the Hip Joint 417
Petter, Charles K. Handy Bone-Grasping Forceps 1084
Pheasant, Homer C., and **Pitkin, Horace C.** Sacrarthrogenetic Telalgia. I. A Study of Referred Pain 111
Sacrarthrogenetic Telalgia. II. A Study of Sacral Mobility 365
Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis 706
Pitkin, Horace C. Sacrarthrogenetic Telalgia. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis 1008
Pitkin, Horace C., and **Pheasant, Homer C.** Sacrarthrogenetic Telalgia. I. A Study of Referred Pain 111
Sacrarthrogenetic Telalgia. II. A Study of Sacral Mobility 365
Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis 706
Poverman, David. Locking of the Hip Joint Due to Osteochondroma of the Lesser Trochanter 1080

R

Ransohoff, Nicholas, and **Mayer, Leo.** Reconstruction of the Digital-Tendon Sheath. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons 607
Reed, Edward N. A Method of Anchoring Kirschner Wires 532
Regen, Eugene M., and **Wilkins, Walter E.** The Effect of Large Doses of X-Rays on the Growth of Young Bone 61
The Influence of Roentgen Irradiation on the Rate of Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone 69
Reich, Rudolph S. Treatment of Intercondylar Fractures of the Elbow by Means of Traction 997
Rendich, Richard A., and **Shapiro, A. V.** Osteitis Condensans Ilii 899
Richard, André. Arthrodesis of the Hip for Coxalgia in Children. Translated from the French by **Alan H. Todd** 49
Risser, Joseph C., and **Ferguson, Albert B.** Scoliosis: Its Prognosis 667
Ritter, Henry H., and **Ludlum, Walter D., Jr.** Intratarsal Dislocation. Report of a Case of Anterior Midtarsal Dislocation 773
Rizzo, Peter Cyrus, and **Wagner, Lewis Clark.** Stabilization of the Hip by the Transplantation of the Anterior Thigh Muscles 180
Roberts, Sumner M., and **Cave, Edwin F.** A Method for Measuring and Recording Joint Function 455
Robin, Nathaniel H., Robin, Percival A., and **Hudson, Otho C.** Interesting Malignant Bone Tumors 215
Robin, Percival A., Hudson, Otho C., and **Robin, Nathaniel H.** Interesting Malignant Bone Tumors 215
Rogers, Mark H., and **Ulin, Robert.** Fractures in Paget's Disease 914
Rombold, Charles. Osteochondritis Dissecans of the Patella. A Case Report.... 230

S

Samson, J. Ed. Arthroplasty of the Knee Joint 881
Schmier, Adolph A. Fracture-Dislocation of the Elbow with Ulnar-Nerve Involvement. Reduction by Tension on the Superficial Flexor Group of Muscles 1030
Schofield, Richard O. Fractures of the Os Calcis 566
Schwartz, R. Plato, Trautmann, Otto, and **Heath, Arthur L.** Gait and Muscle Function Recorded by the Electrobasograph 445
Scott, Walter. Epiphysiolysis of the Upper Femur. A Report of Thirty-Eight Cases 743
Shapiro, A. V., and **Rendich, Richard A.** Osteitis Condensans Ilii 899

PAGE

Shelton, E. Kost, Sutherland, Ross, and **Cavanaugh, Lyman A.** Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis 957
Siegling, John A., and **Fahey, John J.** The Fate of Transplanted Cow's Horn .. 439
Sloane, David, Sloane, Marian Frauenthal, and **Gold, Aaron M.** Dyschondroplastic Bow Legs 183
Sloane, Marian Frauenthal, Gold, Aaron M., and **Sloane, David.** Dyschondroplastic Bow Legs 183
Smith-Petersen, M. N. Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty 869
Snodgrass, L. E. Compound Cystic Bursitis of the Knee Joint 229
Snyder, C. H., Badgley, Carl E., Yglesias, Luis, and **Perham, W. S.** Study of the End Results in 113 Cases of Septic Hips 1047
Speed, J. S., and **Boyd, H. B.** Operative Reconstruction of Malunited Fractures about the Ankle Joint 270
Stein, Irvin, and **Gill, A. Bruce.** Bone Metabolism: Its Principles and Its Relations to Orthopaedic Surgery 941
Stern, Walter G. Acute Transverse Bone Atrophy 659
Sutherland, Ross, Cavanaugh, Lyman A., and **Shelton, E. Kost.** Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis 957
Swaim, Loring T. Prevention of Deformity in Arthritis 80
Swart, Howard A., and **Henderson, Melvin S.** Chronic Osteomyelitis Associated with Malignancy 56
Swift, Walker E. Frozen-Section Diagnosis of Tuberculous Joints 641

T

Thomas, Henry Bascom. Some Orthopaedic Findings in Ninety-Eight Cases of Hemophilia 140
Thomson, J. E. M. Fractures of the Forearm Reduced by Direct Leverage 397
Thomson, J. E. M., and **Ferciot, C. Fred.** A Tautening Bolt for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of Fractures .. 245
Todd, Alan H. Translation from the French of: Osteosynthesis in Spinal Tuberculosis. By **Jacques Calvé** and **Marcel Galland** 46
Translation from the French of: Treatment of Quiescent Tumor Albus and Pseudarthrosis of Tuberculous Origin in Children. By **A. Delahaye** 51
Translation from the French of: Arthrodesis of the Hip for Coxalgia in Children. By **André Richard** 49
Trautmann, Otto, Heath, Arthur L., and **Schwartz, R. Plato.** Gait and Muscle Function Recorded by the Electrobasograph 445
Turner, Henry. Some Thoughts on the Probable Causes of Non-Union of Fractures 581

U

Ulin, Robert, and **Rogers, Mark H.** Fractures in Paget's Disease 914

W

Wagner, Lewis Clark, and **Rizzo, Peter Cyrus.** Stabilization of the Hip by the Transplantation of the Anterior Thigh Muscles 180
Wakefield, Elmer G., and **Dellinger, Samuel C.** The Probable Adaptation of Utilitarian Implements for Surgical Procedures by the "Mound Builders" of Eastern Arkansas 434
Weisengreen, H. H. The Selection of the Anaesthetic in Cases of Fracture of the Jaw 1005
Wilkins, Walter E., and **Regen, Eugene M.** The Effect of Large Doses of X-Rays on the Growth of Young Bone 61
The Influence of Roentgen Irradiation on the Rate of Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone 69
Wilmoth, Clifford Lee. Tunica Vaginalis in Arthroplasty of Small Joints 165
Wilson, John C., and **McKeever, Francis M.** Hematogenous Acute Osteomyelitis in Children 328
Wilson, Philip D. Fracture of the Lateral Condyle of the Humerus in Childhood 301

Y

Yergason, R. M. A Common Cause of Genu Valgum and a Suggestion for Its Treatment 533
Yglesias, Luis, Perham, W. S., Snyder, C. H., and **Badgley, Carl E.** Study of the End Results in 113 Cases of Septic Hips 1047

TITLES OF ARTICLES

A

PAGE

Abscesses, The Occurrence of, from Tuberculous Hips That Are Firmly Ankylosed. Z. B. Adams ... 974

Absence, Congenital, of the Medial Sesamoid Bone of the Great Toe. Report of Two Cases. George A. L. Inge ... 188

Acetabuloplasty, Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of. M. N. Smith-Petersen ... 869

Acetabulum, Fracture of the, with Central Dislocation of the Head of the Femur. A Method of Treatment. Frederick A. Jostes ... 483

Acetabulum, Fracture of the, Posterior Dislocation of the Hip with. Willis C. Campbell ... 842

Acetabulum, Intrapelvic Protrusion of the, and Coxa Plana, Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, by Means of Acetabuloplasty. M. N. Smith-Petersen ... 869

(Acromion Process), Acute Hematogenous Osteomyelitis of the Scapula. Robert D. Fairchild ... 232

(Acromion Process), Acute Osteomyelitis of the Scapula. W. E. Brogden ... 795

Acute Hematogenous Osteomyelitis of the Scapula (Acromion Process). Robert D. Fairchild ... 232

Acute Osteomyelitis, Hematogenous, in Children. John C. Wilson and Francis M. McKeever ... 328

Acute Osteomyelitis of the Scapula (Acromion Process). W. E. Brogden ... 795

Acute Transverse Bone Atrophy. Walter G. Stern ... 659

Adhesive Boot, A Simple, for the Prevention of Foot-Drop in Traction-Suspension Procedures. H. Davis Chipps ... 788

Adjustable Shoulder Strap for Postoperative Torticollis Cast. Fremont A. Chandler ... 239

Alternating Scoliosis, III. A Study of. Sacrarthrogenetic Telalgia. Horace C. Pitkin and Homer C. Pheasant ... 706

American Academy of Orthopaedic Surgeons ... 249, 263, 539, 1088

American Board of Orthopaedic Surgery ... 539, 1087

American Medical Association ... 805

American Orthopaedic Association ... 537, 559, 802

American Public Health Association ... 804, 1088

American Society for the Study of Arthritis ... 249

Amputation for Sarcoma of the Neck of the Femur by the Interinnomino-Abdominal Method. R. R. Fitzgerald ... 402

Amputation Guard, A Useful. Francis M. Findlay ... 236

Anaesthetic, The Selection of the, in Cases of Fracture of the Jaw. H. H. Weisengreen ... 1005

Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for Anterior Distortion. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. ... 1018

Ankle Fracture, Rare, (Maisonneuve-Cotton Type), Correction of Diastasis after Reduction of. A New Use for the Knickerbocker Tongs. Edward Raymond Easton ... 979

Ankle Joint, Operative Reconstruction of Malunited Fractures about the. J. S. Speed and H. B. Boyd ... 270

Ankylosed Extremities, Fracture of. Sigmund Epstein ... 529

[Ankylosis.] The Occurrence of Abscesses from Tuberculous Hips That Are Firmly Ankylosed. Z. B. Adams ... 974

Anterior Distortion, Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. ... 1018

Apophyseal Subluxation. Disturbances in and about the Intervertebral Foramen Causing Back Pain. Lee A. Hadley ... 428

Apparatus for Correction of Subluxation of the Tibial Head, An. Jay L. Hutchison 510

Apparatus

Adjustable Shoulder Strap for Postoperative Torticollis Cast. Fremont A. Chandler ... 239

An Apparatus for Correction of Subluxation of the Tibial Head. Jay L. Hutchison ... 510

A Common Cause of Genu Valgum and a Suggestion for Its Treatment. R. M. Yergason ... 533

PAGE

A Form of Balanced Traction. A Modification of Russell Traction. A. Marians ... 234
A Guide for the Parham Band. S. K. Livingston ... 228
Handy Bone-Grasping Forceps. Charles K. Petter ... 1084
A Hip Brace. David M. Bosworth ... 238
An Inexpensive Portable Therapeutic Pool. Philip Palew ... 247
An Instrument to Aid in the Reduction of Bennett Fractures. Otho C. Hudson ... 1085
The Ischial Seat Brace. A Substitute for the Thomas Ring Brace. Walter I. Galland ... 790
A Method of Anchoring Kirschner Wires. Edward N. Reed ... 532
A Modification of the Balkan Frame. H. O. Foucar ... 526
A New Plaster-of-Paris Cutter. Joseph K. Narat ... 793
Osteocamp for Osteotomoclasis. David M. Bosworth ... 648
A Pelvic-Band Leg Brace with Two-Way Motion at the Hip. Edwin F. Patton ... 794
A Simple Adhesive Boot for the Prevention of Foot-Drop in Traction-Suspension Procedures. H. Davis Chipps ... 788
A Simple Method for the Ambulatory Correction of Flexion Contracture of the Knee. The Use of Continuous Elastic Tension as the Corrective Force. Sidney S. Gaynor ... 766
A Tautening Bolt for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of Fractures. J. E. M. Thomson and C. Fred Ferciot ... 245
A Three-Point Hyperextension Back Brace. R. A. Griswold ... 784
A Traction Sleeve. Robert T. Findlay ... 796
Turnbuckle Brace. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. Joseph S. Barr and Karl Buschenfeldt ... 760
A Useful Amputation Guard. Francis M. Findlay ... 236
Argentine Society of Orthopaedic Surgery ... 805
[Arm.] Fractures of the Forearm Reduced by Direct Leverage. J. E. M. Thomson ... 397
Arthritis, Chronic Rheumatoid, Streptococcic Dissociation in the Pathogenesis of. L. G. Hadjopoulos and Reginald Burbank ... 19
Arthritis, Experimental and Pathological Studies in the Degenerative Type of. Walter Bauer and Granville A. Bennett ... 1
Arthritis, Prevention of Deformity in. Loring T. Swaim ... 80
Arthritis, Rheumatoid, Roentgenographic Features of. Albert B. Ferguson ... 297
Arthritis as a Teaching Problem. Robert W. Johnson, Jr. ... 865
Arthrodesis of the Hip for Coxalgia in Children. André Richard. Translated from the French by Alan H. Todd ... 49
Arthrodesis, Intra-Articular, of the Hip Joint, Some Considerations on Subtrochanteric Osteotomy and. Ernst Freund ... 654
Arthrodesis, Panastragaloid. A Study of End Results in Eighty-Five Cases. W. R. Hamsa ... 732
[Arthrodesis.] Surgical Treatment of Sacrocoxalgia. Louis Allard ... 54
[Arthrodesis.] Treatment of Quiescent Tumor Albus and Pseudarthrosis of Tuberculous Origin in Children. A. Delahaye. Translated from the French by Alan H. Todd ... 51
Arthroplasty of the Knee Joint. J. Ed. Samson ... 881
Arthroplasty of Small Joints, Tunica Vaginalis in. Clifford Lee Wilmoth ... 165
Articular Facets, Study of Fusion of the Spine with Particular Reference to. S. L. Haas ... 717
Astragalocalcaneal Fusion, Congenital. Sidney S. Gaynor ... 479
Astragalus, Total Dislocation of the. Joseph I. Mitchell ... 212
Asymmetry, Congenital Total Unilateral Somatic. Hemihypertrophy and Hemiatrophy. Charles W. Peabody ... 466
Atrophy, Bone, Acute Transverse. Walter G. Stern ... 659

B

[Back.] Lumbosacral Fusion for the Relief of Low-Back Pain. A Report of Thirty-Five Cases. Harold G. Lee ... 375
[Back.] The Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of Low-Back Disabilities and Sciatica. Frank R. Ober ... 105
[Back.] Sacrarthrogenetic Telalgia. I. A Study of Referred Pain. Horace C. Pitkin and Homer C. Pheasant ... 111

PAGE

[Back.] Sacrarthrogenetic Telalgia. II. A Study of Sacral Mobility. Horace C. Pitkin and Homer C. Pheasant ... 365
[Back.] Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis. Horace C. Pitkin and Homer C. Pheasant ... 706
[Back.] Sacrarthrogenetic Telalgia. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis. Horace C. Pitkin ... 1008
[Back.] Study of Fusion of the Spine with Particular Reference to Articular Facets. S. L. Haas ... 717
Back Brace, A Three-Point Hyperextension. R. A. Griswold ... 784
Back Pain, Disturbances in and about the Intervertebral Foramen Causing. Apophyseal Subluxation. Lee A. Hadley ... 428
Balanced Traction, A Form of. A Modification of Russell Traction. A. Marians 234
Balkan Frame, A Modification of the. H. O. Foucar ... 526
Band, Parham, A Guide for the. S. K. Livingston ... 228
Bandages, Closed Plaster-of-Paris, The Treatment of Surgical Tuberculosis by Vaselin Injections and. Vladimír Jeřábek ... 851
Benign Giant-Cell Tumor of the Fourth Lumbar Vertebra. A Case Report. George A. Duncan and Albert B. Ferguson ... 769
Benign Giant-Cell Tumors, Treatment of. Henry W. Meyerding ... 823
Bennett Fractures, An Instrument to Aid in the Reduction of. Otho C. Hudson 1085
Bilateral Giant Meniscus. Maurice H. Herzmark ... 1082
Bilateral Recurrent Dislocation of the Ulna at the Elbow. Henry Milch ... 777
Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation, A Method of. Wilbur J. Cox 134
Böhm, Max ... 1087
Bolt, A Tautening, for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of Fractures. J. E. M. Thomson and C. Fred Ferciot 245
Bone Atrophy, Acute Transverse. Walter G. Stern ... 659
[Bone Graft.] The Fate of Transplanted Cow's Horn. John A. Siegling and John J. Fahey ... 439
Bone Graft as a Means of Internal Fixation, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a. Wilbur J. Cox 134
Bone Graft, Tibial, Use of the, as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture. Indications for and against the Leg-Lengthening Operation. Edward L. Compere ... 692
Bone-Grasping Forceps, Handy. Charles K. Petter ... 1084
Bone Growth, Longitudinal, The Effect of Lumbar Sympathetic Ganglionectomy on, as Determined by the Teleoroentgenographic Method. John J. Fahey 1042
[Bone Innervation.] Some Thoughts on the Probable Causes of Non-Union of Fractures. Henry Turner ... 581
Bone Metabolism: Its Principles and Its Relations to Orthopaedic Surgery. A. Bruce Gill and Irvin Stein ... 941
Bone Tumors, Difficulties in the Diagnosis of. R. I. Harris ... 631
Bone Tumors, Interesting Malignant. Otho C. Hudson, Nathaniel H. Robin, and Percival A. Robin ... 215
Bone Tumors, Roentgen-Ray Therapy of. Henry W. Meyerding ... 617
Boot, A Simple Adhesive, for the Prevention of Foot-Drop in Traction-Suspension Procedures. H. Davis Chipps ... 788
Bordeaux Orthopaedic Society ... 538
Bow Legs, Dyschondroplastic. David Sloane, Marian Frauenthal Sloane, and Aaron M. Gold ... 183
Brace, Back, A Three-Point Hyperextension. R. A. Griswold ... 784
Brace, A Hip. David M. Bosworth ... 238
Brace, The Ischial Seat. A Substitute for the Thomas Ring Brace. Walter I. Galland ... 790
Brace, Leg, A Pelvic-Band, with Two-Way Motion at the Hip. Edwin F. Patton 794
Brace, Turnbuckle. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. Joseph S. Barr and Karl Buschenfeldt ... 760
Brainerd Hunt Whitbeck ... 535
Brazilian Society of Orthopaedic and Traumatic Surgery ... 806
British Orthopaedic Association ... 540, 804, 1087
Bursae, Enlarged Intermetatarsophalangeal, of Both Feet. A Case Report. Herman S. Lieberman ... 1062
Bursitis, Compound Cystic, of the Knee Joint. L. E. Snodgrass ... 229

C

Calcification, Supratrochanteric. Raphael R. Goldenberg and Gottlieb S. Leventhal ... 205

PAGE

[Calcium Resorption.] Acute Transverse Bone Atrophy. Walter G. Stern 659
Callus of Adult Bone, The Influence of Roentgen Irradiation on the Rate of Healing of Fractures and the Phosphatase Activity of the. Eugene M. Regen and Walter E. Wilkins 69
Capital Femoral Epiphysis, Metabolic Studies in Osteochondritis of the. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland 957
[Carrell-Girard Screw.] End Results in 100 Fractures Treated by Internal Removable Fixation. W. B. Carrell 408
[Cartilage, Semilunar.] Bilateral Giant Meniscus. Maurice H. Herzmark 1082
Cartilages, Semilunar, The Function of. Don King 1069
Cartilages, Semilunar, The Healing of. Don King 333
Cast, Postoperative Torticollis, Adjustable Shoulder Strap for. Fremont A. Chandler 239
[Cautery.] The Probable Adaptation of Utilitarian Implements for Surgical Procedures by the "Mound Builders" of Eastern Arkansas. Elmer G. Wakefield and Samuel C. Dellinger 434
[Celloidin-Tube Implantation.] Reconstruction of the Digital-Tendon Sheath. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons. Leo Mayer and Nicholas Ransohoff 607
Cervical Spine, Localized Hypertrophic Changes in the, with Compression of the Spinal Cord or of Its Roots. S. A. Morton 893
Chest, A Method of Immobilizing the. Adolph M. Brown 787
Chronic Osteomyelitis Associated with Malignancy. Melvin S. Henderson and Howard A. Swart 56
Chronic Osteomyelitis, A Method of Dealing with, by Saucerization Followed by Skin-Grafting. Basil Armstrong and T. Francis Jarman 387
[Chronic Osteomyelitis.] The Therapeutic Active Principle of Maggots with a Description of Its Clinical Application in 567 Cases. S. K. Livingston 751
Chronic Rheumatoid Arthritis, Streptococcic Dissociation in the Pathogenesis of. L. G. Hadjopoulos and Reginald Burbank 19
Closed Plaster-of-Paris Bandages, The Treatment of Surgical Tuberculosis by Vaselin Injections and. Vladimír Jeřábek 851
Club Feet, The Treatment of. Lloyd T. Brown 173
[Club-Foot.] Surgical Management of Pes Calcaneus. O. L. Miller 169
Colon-Bacillus Osteomyelitis. Morris B. Cooperman and Gottlieb S. Leventhal 242
Common Cause of Genu Valgum and a Suggestion for Its Treatment, A. R. M. Yergason 533
Compound Cystic Bursitis of the Knee Joint. L. E. Snodgrass 229
Compression Fracture of the Spine. A Three-Point Hyperextension Back Brace. R. A. Griswold 784
Condyle, Lateral, of the Humerus, Fracture of the, in Childhood. Philip D. Wilson 301
Condyle, Lateral Tibial, Cortical Avulsion Fracture of the. Henry Milch 159
Congenital Absence of the Medial Sesamoid Bone of the Great Toe. Report of Two Cases. George A. L. Inge 188
Congenital Anomaly of the Coracoid. Os Coracosternale Vestigiale. Jerome G. Finder 148
Congenital Astragalocalcaneal Fusion. Sidney S. Gaynor 479
Congenital Dislocation of the Hip, Analysis of Results of Early Treatment of, by Manipulation and Osteoclasis for Anterior Distortion. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. 1018
Congenital Dislocation of the Hip, An Evaluation of Present-Day Methods of Dealing with. A. Bruce Gill 487
Congenital Pseudarthrosis, Localized Osteitis Fibrosa in the New-Born and. Edward L. Compere 513
Congenital Total Unilateral Somatic Asymmetry. Hemihypertrophy and Hemiatrophy. Charles W. Peabody 466
Congress of Railway Surgeons 1087
Contracture, Flexion, of the Knee, A Simple Method for the Ambulatory Correction of. The Use of Continuous Elastic Tension as the Corrective Force. Sidney S. Gaynor 766
Coracoid, Congenital Anomaly of the. Os Coracosternale Vestigiale. Jerome G. Finder 148
Cortical Avulsion Fracture of the Lateral Tibial Condyle. Henry Milch 159
Cow's Horn, Transplanted, The Fate of. John A. Siegling and John J. Fahey 439
Coxalgia in Children, Arthrodesis of the Hip for. André Richard. Translated from the French by Alan H. Todd 49
Coxa Plana, Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and, by Means of Acetabuloplasty. M. N. Smith-Petersen 869

PAGE

Crucial Ligaments, Ruptured, Use of Fascia Lata to Stabilize the Knee in Cases of. David M. Bosworth and Boardman M. Bosworth 178
Cunningham, Samuel R. 1086
Current Literature 251, 543, 808, 1090
Cutter, A New Plaster-of-Paris. Joseph K. Narat 793
Cyst, Epidermoid, in Bone of Skull. J. Harold Couch 475
Cystic Bursitis, Compound, of the Knee Joint. L. E. Snodgrass 229
Czechoslovakian Orthopaedic Society 250, 538

D

Deformity in Arthritis, Prevention of. Loring T. Swaim 80
Deformities, Extension, of the Proximal Interphalangeal Joints of the Fingers. An Anatomical Study. Emanuel B. Kaplan 781
[Deformities, Paralytic.] Panastragaloid Arthrodesis. A Study of End Results in Eighty-Five Cases. W. R. Hamsa 732
Delayed Union, Non-Union, or Late Fracture, Use of the Tibial Bone Graft as a Factor in Preventing. Indications for and against the Leg-Lengthening Operation. Edward L. Compere 692
Deutsche Gesellschaft für Unfallheilkunde, Versicherungs- und Versorgungsmedizin 806
Deutsche orthopädische Gesellschaft 249, 250, 538, 805
Diagnosis of Bone Tumors, Difficulties in the. R. I. Harris 631
Diagnosis, Differential, in Sacrarthrogenetic Scoliosis, IV. Sacrarthrogenetic Telalgia. Horace C. Pitkin 1008
Diagnosis, Frozen-Section, of Tuberculous Joints. Walker E. Swift 641
Diastasis, Correction of, after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type). A New Use for the Knickerbocker Tongs. Edward Raymond Easton 979
Difficulties in the Diagnosis of Bone Tumors. R. I. Harris 631
Digital-Tendon Sheath, Reconstruction of the. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons. Leo Mayer and Nicholas Ransohoff 607
Direct Leverage, Fractures of the Forearm Reduced by. J. E. M. Thomson 397
Disabilities, Low-Back, and Sciatica, The Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of. Frank R. Ober 105
Dislocation, Anterior Midtarsal, Report of a Case of. Intratarsal Dislocation. Henry H. Ritter and Walter D. Ludlum, Jr. 773
Dislocation, Bilateral Recurrent, of the Ulna at the Elbow. Henry Milch 777
Dislocation, Central, of the Head of the Femur, Fracture of the Acetabulum with. A Method of Treatment. Frederick A. Jostes 483
Dislocation, Congenital, of the Hip, Analysis of Results of Early Treatment of, by Manipulation and Osteoclasis for Anterior Distortion. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. 1018
Dislocation, Congenital, of the Hip, An Evaluation of Present-Day Methods of Dealing with. A. Bruce Gill 487
Dislocation of the Elbow Reduced by Means of Traction in Four Directions. Edward H. Crosby 1077
Dislocation, Fracture-, of the Elbow with Ulnar-Nerve Involvement. Reduction by Tension on the Superficial Flexor Group of Muscles. Adolph A. Schmier 1030
Dislocation, Intratarsal. Report of a Case of Anterior Midtarsal Dislocation. Henry H. Ritter and Walter D. Ludlum, Jr. 773
Dislocation, Pathological, of the Hip in Children, Stabilization of. J. B. L'Episcopo 737
Dislocation, Pathological, of the Sacro-Iliac Joint. J. B. L'Episcopo 524
Dislocation, Posterior, of the Hip with Fracture of the Acetabulum. Willis C. Campbell 842
Dislocation, Total, of the Astragalus. Joseph I. Mitchell 212
Dislocations, Old, of the Shoulder. George E. Bennett 594
Dislocations about the Shoulder, Fractures and. Robert V. Funsten and Prentice Kinser 191
Displacement, Old Traumatic, of the Distal Femoral Epiphysis. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal 199
Distortion, Anterior, Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and Osteoclasis for. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. 1018
Dyschondroplastic Bow Legs. David Sloane, Marian Frauenthal Sloane, and Aaron M. Gold 183

PAGE

E

Effect of Large Doses of X-Rays on the Growth of Young Bone, The. Eugene M. Regen and Walter E. Wilkins 61
Effect of Lumbar Sympathectomy upon the Growth of Legs Paralyzed by Anterior Poliomyelitis, The. R. I. Harris and J. L. McDonald 35
Effect of Lumbar Sympathetic Ganglionectomy on Longitudinal Bone Growth as Determined by the Teleoroentgenographic Method, The. John J. Fahey . . . 1042
Effects of Hypercalcaemia on Joints, The. H. C. Fang and Leo J. Miltner 909
Elastic Tension, Continuous, The Use of, as the Corrective Force. A Simple Method for the Ambulatory Correction of Flexion Contracture of the Knee. Sidney S. Gaynor 766
[Elastic Traction.] The Treatment of Club Feet. Lloyd T. Brown 173
Elbow, Bilateral Recurrent Dislocation of the Ulna at the. Henry Milch 777
Elbow, Dislocation of the, Reduced by Means of Traction in Four Directions. Edward H. Crosby 1077
Elbow, Fracture-Dislocation of the, with Ulnar-Nerve Involvement. Reduction by Tension on the Superficial Flexor Group of Muscles. Adolph A. Schmier . . . 1030
[Elbow.] Fracture of the Lateral Condyle of the Humerus in Childhood. Philip D. Wilson 301
[Elbow.] Fractures of the Supracondylar Process of the Humerus. Clarmont Paul Doane 757
Elbow, Intercondylar Fractures of the, Treatment of, by Means of Traction. Rudolph S. Reich 997
Elbow, Tennis, The Pathology and Treatment of. J. H. Cyriax 921
Electrobasograph, Gait and Muscle Function Recorded by the. R. Plato Schwartz, Otto Trautmann, and Arthur L. Heath 445
End Results of the Fractured Distal Tibial Epiphysis, The. Alexander P. Aitken 685
End Results of Fractures of the Proximal Humeral Epiphysis. Alexander P. Aitken 1036
End Results in 100 Fractures Treated by Internal Removable Fixation. W. B. Carrell 408
Enlarged Intermetatarsophalangeal Bursae of Both Feet. A Case Report. Herman S. Lieberman 1062
Epidermoid Cyst in Bone of Skull. J. Harold Couch 475
Epiphyseal Arrest of the Normal Femur, Successful Open Reduction Followed by, Old Traumatic Displacement of the Distal Femoral Epiphysis. Daniel H. Levinthal 199
Epiphysiolysis of the Upper Femur. A Report of Thirty-Eight Cases. Walter Scott 743
Epiphysis, Capital Femoral, Metabolic Studies in Osteochondritis of the. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland 957
Epiphysis, Distal Femoral, Old Traumatic Displacement of the. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal 199
Epiphysis, Fractured Distal Tibial, The End Results of the. Alexander P. Aitken 685
[Epiphysis, Humeral.] An Unusual Shoulder Lesion. David M. Bosworth 1078
[Epiphysis.] Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the Femur. Domenico Logròscino. Translated from the Italian by Ernst Freund 671
Epiphysis, Old Slipped Upper Femoral, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana, Treatment of Malum Coxae Senilis, by Means of Acetabuloplasty. M. N. Smith-Petersen 869
Epiphysis, Proximal Humeral, End Results of Fractures of the. Alexander P. Aitken 1036
Ernest Muirhead Little 249, 534
Evaluation of Present-Day Methods of Dealing with Congenital Dislocation of the Hip, An. A. Bruce Gill 487
Experimental and Pathological Studies in the Degenerative Type of Arthritis. Walter Bauer and Granville A. Bennett 1
Extension Deformities of the Proximal Interphalangeal Joints of the Fingers. An Anatomical Study. Emanuel B. Kaplan 781
Extremities, Ankylosed, Fracture of. Sigmund Epstein 529

F

Fascia Lata as a Factor in the Causation of Low-Back Disabilities and Sciatica, The Rôle of the Iliotibial Band and. Frank R. Ober 105

PAGE

Fascia Lata, Use of, to Stabilize the Knee in Cases of Ruptured Crucial Ligaments. David M. Bosworth and Boardman M. Bosworth 178
Fate of Transplanted Cow's Horn, The. John A. Siegling and John J. Fahey ... 439
Feet, Both, Enlarged Intermetatarsophalangeal Bursae of. A Case Report. Herman S. Lieberman 1062
Femoral Epiphysis, Capital, Metabolic Studies in Osteochondritis of the. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland 957
Femoral Epiphysis, Distal, Old Traumatic Displacement of the. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal 199
Femoral Epiphysis, Old Slipped Upper, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana, Treatment of Malum Coxae Senilis, by Means of Acetabuloplasty. M. N. Smith-Petersen 869
Femur, Amputation for Sarcoma of the Neck of the, by the Interinnomino-Abdominal Method. R. R. Fitzgerald 402
Femur, Fracture of the Acetabulum with Central Dislocation of the Head of the. A Method of Treatment. Frederick A. Jostes 483
Femur, Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the. Domenico Logròscino. Translated from the Italian by Ernst Freund 671
Femur, A Method of Blind Pegging Fractures of the Neck of the, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation. Wilbur J. Cox 134
Femur, Normal, Successful Open Reduction Followed by Epiphyseal Arrest of the. Old Traumatic Displacement of the Distal Femoral Epiphysis. Daniel H. Levinthal 199
[Femur.] Osteocamp for Osteotomoclasis. David M. Bosworth 648
Femur, Osteomyelitis of the, Fractures Occurring after Operation for, with Ultimate Union. Charles H. Frantz 969
Femur, Ununited Fractures of the Neck of the. T. P. McMurray 319
Femur, Upper, Epiphysiolysis of the. A Report of Thirty-Eight Cases. Walter Scott 743
Fingers, Extension Deformities of the Proximal Interphalangeal Joints of the. An Anatomical Study. Emanuel B. Kaplan 781
[Fingers.] Fractures of the Proximal Phalanges. Alignment and Immobilization. S. A. Jahss 726
Finger Tendons, Damaged, A Contribution to the Physiological Method of Repair of. Reconstruction of the Digital-Tendon Sheath. Leo Mayer and Nicholas Ransohoff 607
[Fixation, Internal.] The Fate of Transplanted Cow's Horn. John A. Siegling and John J. Fahey 439
Fixation, Internal, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of. Wilbur J. Cox 134
Fixation, Internal Removable, End Results in 100 Fractures Treated by. W. B. Carrell 408
Fixed Paralytic Pelvic Obliquity, Further Studies of. Leo Mayer 87
Flexion Contracture of the Knee, A Simple Method for the Ambulatory Correction of. The Use of Continuous Elastic Tension as the Corrective Force. Sidney S. Gaynor 766
[Flowing Hyperostosis.] Melorheostosis Léri. A Case Report. Richard B. Dillehunt and Eldon G. Chuinard 991
[Foot.] Intratarsal Dislocation. Report of a Case of Anterior Midtarsal Dislocation. Henry H. Ritter and Walter D. Ludlum, Jr. 773
Foot. Tuberculosis of the Bones of the, Prognosis and Treatment of. Leo J. Miltner and H. C. Fang 287
Foot-Drop, A Simple Adhesive Boot for the Prevention of, in Traction-Suspension Procedures. H. Davis Chipps 788
Foramen, Intervertebral, Disturbances in and about the, Causing Back Pain. Apophyseal Subluxation. Lee A. Hadley 428
Forceps, Handy Bone-Grasping. Charles K. Petter 1084
Forearm, Fractures of the, Reduced by Direct Leverage. J. E. M. Thomson ... 397
Form of Balanced Traction, A. A Modification of Russell Traction. A. Marians 234
Fracture of the Acetabulum with Central Dislocation of the Head of the Femur. A Method of Treatment. Frederick A. Jostes 483
Fracture of the Acetabulum, Posterior Dislocation of the Hip with. Willis C. Campbell 842

PAGE

Fracture of Ankylosed Extremities. Sigmund Epstein 529
Fracture, Cortical Avulsion, of the Lateral Tibial Condyle. Henry Milch. 159
Fracture of the Jaw, The Selection of the Anaesthetic in Cases of. H. H. Weisengreen 1005
Fracture, Late, Use of the Tibial Bone Graft as a Factor in Preventing Delayed Union, Non-Union, or. Indications for and against the Leg-Lengthening Operation. Edward L. Compere 692
Fracture of the Lateral Condyle of the Humerus in Childhood. Philip D. Wilson 301
Fracture, Rare Ankle (Maisonneuve-Cotton Type), Correction of Diastasis after Reduction of. A New Use for the Knickerbocker Tongs. Edward Raymond Easton 979
[Fracture of the Spine.] A Three-Point Hyperextension Back Brace. R. A. Griswold 784
[Fracture Clinic, End-Result Study.] A Method for Measuring and Recording Joint Function. Edwin F. Cave and Sumner M. Roberts 455
Fracture-Dislocation of the Elbow with Ulnar-Nerve Involvement. Reduction by Tension on the Superficial Flexor Group of Muscles. Adolph A. Schmier . . . 1030
Fractured Distal Tibial Epiphysis, The End Results of the. Alexander P. Aitken 685
[Fractures.] Acute Transverse Bone Atrophy. Walter G. Stern 659
Fractures, Bennett, An Instrument to Aid in the Reduction of. Otho C. Hudson 1085
Fractures and Dislocations about the Shoulder. Robert V. Funsten and Prentice Kinser 191
[Fractures.] The Fate of Transplanted Cow's Horn. John A. Siegling and John J. Fahey 439
Fractures of the Forearm Reduced by Direct Leverage. J. E. M. Thomson. 397
Fractures, The Influence of Roentgen Irradiation on the Rate of Healing of, and the Phosphatase Activity of the Callus of Adult Bone. Eugene M. Regen and Walter E. Wilkins 69
Fractures, Intercondylar, of the Elbow, Treatment of, by Means of Traction. Rudolph S. Reich 997
Fractures, Malunited, about the Ankle Joint, Operative Reconstruction of. J. S. Speed and H. B. Boyd 270
Fractures of the Neck of the Femur, A Method of Blind Pegging of, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation. Wilbur J. Cox 134
Fractures, Non-Union of, Some Thoughts on the Probable Causes of. Henry Turner 581
Fractures Occurring after Operation for Osteomyelitis of the Femur, with Ultimate Union. Charles H. Frantz 969
Fractures of the Os Calcis. Richard O. Schofield 566
Fractures in Paget's Disease. Mark H. Rogers and Robert Ulin 914
Fractures of the Proximal Humeral Epiphysis, End Results of. Alexander P. Aitken 1036
Fractures of the Proximal Phalanges. Alignment and Immobilization. S. A. Jahss 726
Fractures of the Supracondylar Process of the Humerus. Clarmont Paul Doane. 757
Fractures, A Tautening Bolt for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of. J. E. M. Thomson and C. Fred Ferciot 245
Fractures Treated by Internal Removable Fixation, End Results in 100. W. B. Carrell 408
[Fractures, Treatment of.] A Traction Sleeve. Robert T. Findlay 796
Fractures, Ununited, of the Neck of the Femur. T. P. McMurray 319
Fractures, Unusual, of the Spine. Merrill Coleman Mensor and Leon O. Parker 153
Frame, Balkan, A Modification of the. H. O. Foucar 526
French Society of Orthopaedic Surgery 805
Frozen-Section Diagnosis of Tuberculous Joints. Walker E. Swift 641
Function, Joint, A Method for Measuring and Recording. Edwin F. Cave and Sumner M. Roberts 455
Function, Muscle, Recorded by the Electrobasograph, Gait and. R. Plato Schwartz, Otto Trautmann, and Arthur L. Heath 445
Function of Semilunar Cartilages, The. Don King 1069
Further Studies of Fixed Paralytic Pelvic Obliquity. Leo Mayer 87
Fusion, Congenital Astragalocalcaneal. Sidney S. Gaynor 479
Fusion, Lumbosacral, for the Relief of Low-Back Pain. A Report of Thirty-Five Cases. Harold G. Lee 375

PAGE

Fusion of the Spine with Particular Reference to Articular Facets, Study of. S. L. Haas . . . 717
Fusion, Spine, Review of 100 Cases of Scoliosis Treated by. W. E. Brogden . . . 1027

G

Gait and Muscle Function Recorded by the Electrobasograph. R. Plato Schwartz, Otto Trautmann, and Arthur L. Heath . . . 445
Ganglionectomy, Lumbar Sympathetic, The Effect of, on Longitudinal Bone Growth as Determined by the Teleoroentgenographic Method. John J. Fahey . . . 1042
Genu Valgum, A Common Cause of, and a Suggestion for Its Treatment. R. M. Yergason . . . 533
German Orthopaedic Society . . . 249, 250, 538, 805
German Society for Industrial Surgery and Institutional Medicine . . . 806
Giant-Cell Tumors, Benign, Treatment of. Henry W. Meyerding . . . 823
Gland, Prostate, The Relation of the, to Orthopaedic Problems. Wallace S. Duncan . . . 101
Gout: An Unusual Manifestation in a Stump. W. E. Kendall, H. C. Fortner, and S. K. Livingston . . . 240
[Graft, Bone.] The Fate of Transplanted Cow's Horn. John A. Siegling and John J. Fahey . . . 439
Graft, Bone, as a Means of Internal Fixation, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a. Wilbur J. Cox . . . 134
Graft, Tibial Bone, Use of the, as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture. Indications for and against the Leg-Lengthening Operation. Edward L. Compere . . . 692
Grafting, Skin-, A Method of Dealing with Chronic Osteomyelitis by Saucerization Followed by. Basil Armstrong and T. Francis Jarman . . . 387
Growth of Legs Paralyzed by Anterior Poliomyelitis, The Effect of Lumbar Sympathectomy upon the. R. I. Harris and J. L. McDonald . . . 35
Growth, Longitudinal Bone, The Effect of Lumbar Sympathetic Ganglionectomy on, as Determined by the Teleoroentgenographic Method. John J. Fahey . . . 1042
Growth of Young Bone, The Effect of Large Doses of X-Rays on the. Eugene M. Regen and Walter E. Wilkins . . . 61
Guard, Amputation, A Useful. Francis M. Findlay . . . 236
Guide for the Parham Band, A. S. K. Livingston . . . 228

H

Handy Bone-Grasping Forceps. Charles K. Petter . . . 1084
Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone, The Influence of Roentgen Irradiation on the Rate of. Eugene M. Regen and Walter E. Wilkins . . . 69
Healing of Semilunar Cartilages, The. Don King . . . 333
[Heel.] Fractures of the Os Calcis. Richard O. Schofield . . . 566
Hematogenous Acute Osteomyelitis in Children. John C. Wilson and Francis M. McKeever . . . 328
Hematogenous Osteomyelitis, Acute, of the Scapula (Acromion Process). Robert D. Fairchild . . . 232
Hemiatrophy, Hemihypertrophy and. Congenital Total Unilateral Somatic Asymmetry. Charles W. Peabody . . . 466
Hemihypertrophy and Hemiatrophy. Congenital Total Unilateral Somatic Asymmetry. Charles W. Peabody . . . 466
Hemophilia, Some Orthopaedic Findings in Ninety-Eight Cases of. Henry Bascom Thomas . . . 140
Hip, Arthrodesis of the, for Coxalgia in Children. André Richard. Translated from the French by Alan H. Todd . . . 49
Hip, Congenital Dislocation of the, Analysis of Results of Early Treatment of, by Manipulation and Osteoclasis for Anterior Distortion. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. . . . 1018
Hip, Congenital Dislocation of the, An Evaluation of Present-Day Methods of Dealing with. A. Bruce Gill . . . 487
[Hip.] Epiphysiolysis of the Upper Femur. A Report of Thirty-Eight Cases. Walter Scott . . . 743
[Hip.] Fracture of the Acetabulum with Central Dislocation of the Head of the Femur. A Method of Treatment. Frederick A. Jostes . . . 483
[Hip.] Fractures Occurring after Operation for Osteomyelitis of the Femur, with Ultimate Union. Charles H. Frantz . . . 969

PAGE

[Hip.] Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the Femur. Domenico Logrôscino. Translated from the Italian by Ernst Freund ... 671

[Hip.] Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland ... 957

[Hip.] A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation. Wilbur J. Cox ... 134

[Hip.] Old Traumatic Displacement of the Distal Femoral Epiphysis. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal ... 199

[Hip.] Osteocamp for Osteotomoclasis. David M. Bosworth ... 648

Hip, A Pelvic-Band Leg Brace with Two-Way Motion at the. Edwin F. Patton ... 794

Hip, Posterior Dislocation of the, with Fracture of the Acetabulum. Willis C. Campbell ... 842

Hip, Stabilization of Pathological Dislocation of the, in Children. J. B. L'Episcopo ... 737

Hip, Stabilization of the, by the Transplantation of the Anterior Thigh Muscles. Lewis Clark Wagner and Peter Cyrus Rizzo ... 180

[Hip.] Supratrochanteric Calcification. Raphael R. Goldenberg and Gottlieb S. Leventhal ... 205

[Hip.] Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty. M. N. Smith-Petersen ... 869

[Hip.] Ununited Fractures of the Neck of the Femur. T. P. McMurray ... 319

Hip Brace, A. David M. Bosworth ... 238

Hip Joint, Locking of the, Due to Osteochondroma of the Lesser Trochanter. David Poverman ... 1080

Hip Joint, Pelvic Abscesses Associated with Acute Purulent Infection of the. Joseph A. Freiberg and Robert Perlman ... 417

Hip Joint, Some Considerations on Subtrochanteric Osteotomy and Intra-Articular Arthrodesis of the. Ernst Freund ... 654

Hips, Septic, Study of the End Results in 113 Cases of. Carl E. Badgley, Luis Yglesias, W. S. Perham, and C. H. Snyder ... 1047

Hips, Tuberculous, That Are Firmly Ankylosed, The Occurrence of Abscesses from. Z. B. Adams ... 974

Hospital for Joint Diseases ... 538

Humeral Epiphysis, Proximal, End Results of Fractures of the. Alexander P. Aitken ... 1036

[Humeral Epiphysis.] An Unusual Shoulder Lesion. David M. Bosworth ... 1078

Humerus, Fracture of the Lateral Condyle of the, in Childhood. Philip D. Wilson 301

Humerus, Fractures of the Supracondylar Process of the. Clarmont Paul Doane 757

Hypercalcaemia, The Effects of, on Joints. H. C. Fang and Leo J. Miltner ... 909

Hyperextension Back Brace, A Three-Point. R. A. Griswold ... 784

Hypertrophic Changes, Localized, in the Cervical Spine with Compression of the Spinal Cord or of Its Roots. S. A. Morton ... 893

I

Iliotibial Band and Fascia Lata as a Factor in the Causation of Low-Back Disabilities and Sciatica, The Rôle of the. Frank R. Ober ... 105

[Ilium.] Osteitis Condensans Ilii. Richard A. Rendich and A. V. Shapiro ... 899

Implements, Utilitarian, for Surgical Procedures by the "Mound Builders" of Eastern Arkansas, The Probable Adaptation of. Elmer G. Wakefield and Samuel C. Dellinger ... 434

Indications for and against the Leg-Lengthening Operation. Use of the Tibial Bone Graft as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture. Edward L. Compere ... 692

Inexpensive Portable Therapeutic Pool, An. Philip Palew ... 247

[Infantile Paralysis.] The Effect of Lumbar Sympathectomy upon the Growth of Legs Paralyzed by Anterior Poliomyelitis. R. I. Harris and J. L. McDonald 35

Infection, Acute Purulent, of the Hip Joint, Pelvic Abscesses Associated with. Joseph A. Freiberg and Robert Perlman ... 417

Inflammatory Localized Lesions of the Juxta-Epiphyseal Zone of the Neck of the Femur. Domenico Logrôscino. Translated from the Italian by Ernst Freund ... 671

Influence of Roentgen Irradiation on the Rate of Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone, The. Eugene M. Regen and Walter E. Wilkins ... 69

PAGE

Injections, Vaselin, and Closed Plaster-of-Paris Bandages, The Treatment of Surgical Tuberculosis by. Vladimír Jeřábek ... 851
[Innervation, Bone.] Some Thoughts on the Probable Causes of Non-Union of Fractures. Henry Turner ... 581
Instability of the Knee, A New Operative Procedure for. H. Page Mauck ... 984
Instrument to Aid in the Reduction of Bennett Fractures, An. Otho C. Hudson 1085
Intercondylar Fractures of the Elbow, Treatment of, by Means of Traction. Rudolph S. Reich ... 997
Interesting Malignant Bone Tumors. Otho C. Hudson, Nathaniel H. Robin, and Percival A. Robin ... 215
Interinnomino-Abdominal Method, Amputation for Sarcoma of the Neck of the Femur by the. R. R. Fitzgerald ... 402
Intermetatarsophalangeal Bursae, Enlarged, of Both Feet. A Case Report. Herman S. Lieberman ... 1062
[Internal Fixation.] The Fate of Transplanted Cow's Horn. John A. Siegling and John J. Fahey ... 439
Internal Fixation, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of. Wilbur J. Cox 134
International Conference on Fever Therapy ... 805
International Congress of Sanatoria and Private Nursing Homes ... 804
International Society for Crippled Children, Inc. ... 539
International Society of Orthopaedic Surgery ... 538, 805
Interphalangeal Joints, Proximal, of the Fingers, Extension Deformities of the. An Anatomical Study. Emanuel B. Kaplan ... 781
Intervertebral Foramen, Disturbances in and about the, Causing Back Pain. Apophyseal Subluxation. Lee A. Hadley ... 428
Intra-Articular Arthrodesis of the Hip Joint, Some Considerations on Subtrochanteric Osteotomy and. Ernst Freund ... 654
Intrapelvic Protrusion of the Acetabulum, and Coxa Plana, Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, by Means of Acetabuloplasty. M. N. Smith-Petersen ... 869
Intratarsal Dislocation. Report of a Case of Anterior Midtarsal Dislocation. Henry H. Ritter and Walter D. Ludlum, Jr. ... 773
[Irradiation.] The Effect of Large Doses of X-Rays on the Growth of Young Bone. Eugene M. Regen and Walter E. Wilkins ... 61
Irradiation, Roentgen, The Influence of, on the Rate of Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone. Eugene M. Regen and Walter E. Wilkins ... 69
[Irradiation.] Roentgen-Ray Therapy of Bone Tumors. Henry W. Meyerding 617
Ischial Seat Brace, The. A Substitute for the Thomas Ring Brace. Walter I. Galland ... 790

J

Jaw, Fracture of the, The Selection of the Anaesthetic in Cases of. H. H. Weisengreen ... 1005
John Ridlon ... 799
Joint Function, A Method for Measuring and Recording. Edwin F. Cave and Sumner M. Roberts ... 455
Jones, Robert, Lecture ... 538
Jugoslavian Orthopaedic Society ... 250

K

Kirschner Wire, A Tautening Bolt for Use with, When Plaster-of-Paris Casts Are Used in the Treatment of Fractures. J. E. M. Thomson and C. Fred Fercíot 245
Kirschner Wires, A Method of Anchoring. Edward N. Reed ... 532
[Knee.] Bilateral Giant Meniscus. Maurice H. Herzmark ... 1082
[Knee.] Cortical Avulsion Fracture of the Lateral Tibial Condyle. Henry Milch 159
[Knee.] The Function of Semilunar Cartilages. Don King ... 1089
[Knee.] The Healing of Semilunar Cartilages. Don King ... 333
Knee, Instability of the, A New Operative Procedure for. H. Page Mauck ... 984
[Knee.] Osteochondritis Dissecans of the Patella. A Case Report. Charles Rombold ... 230
Knee, A Simple Method for the Ambulatory Correction of Flexion Contracture of the. The Use of Continuous Elastic Tension as the Corrective Force. Sidney S. Gaynor ... 766
Knee, Use of Fascia Lata to Stabilize the, in Cases of Ruptured Crucial Ligaments. David M. Bosworth and Boardman M. Bosworth ... 178

PAGE

Knee-Flexion Test for Pathology in the Lumbosacral and Sacro-Iliac Joints, The. I. William Nachlas ... 724
Knee Joint, Arthroplasty of the. J. Ed. Samson ... 881
Knee Joint, Compound Cystic Bursitis of the. L. E. Snodgrass ... 229
Knickerbocker Tongs, A New Use for the. Correction of Diastasis after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type). Edward Raymond Easton ... 979
[Knock-Knee.] A Common Cause of Genu Valgum and a Suggestion for Its Treatment. R. M. Yergason ... 533

L

Lateral Condyle of the Humerus, Fracture of the, in Childhood. Philip D. Wilson 301
Leg Brace, A Pelvic-Band, with Two-Way Motion at the Hip. Edwin F. Patton 794
Leg-Lengthening Operation, Indications for and against the. Use of the Tibial Bone Graft as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture. Edward L. Compere ... 692
Legs, Bow, Dyschondroplastic. David Sloane, Marian Frauenthal Sloane, and Aaron M. Gold ... 183
Legs Paralyzed by Anterior Poliomyelitis, The Effect of Lumbar Sympathectomy upon the Growth of. R. I. Harris and J. L. McDonald ... 35
Lesion, Shoulder, An Unusual. David M. Bosworth ... 1078
Lesions, Inflammatory Localized, of the Juxta-Epiphyseal Zone of the Neck of the Femur. Domenico Logrèscino. Translated from the Italian by Ernst Freund ... 671
Lesser Trochanter, Locking of the Hip Joint Due to Osteochondroma of the. David Poverman ... 1080
Leverage, Direct, Fractures of the Forearm Reduced by. J. E. M. Thomson ... 397
Ligaments, Ruptured Crucial, Use of Fascia Lata to Stabilize the Knee in Cases of. David M. Bosworth and Boardman M. Bosworth ... 178
Ligue Internationale contre le Rhumatisme ... 1088
Little, Ernest Muirhead ... 249, 534
Localized Hypertrophic Changes in the Cervical Spine with Compression of the Spinal Cord or of Its Roots. S. A. Morton ... 893
Localized Lesions, Inflammatory, of the Juxta-Epiphyseal Zone of the Neck of the Femur. Domenico Logrèscino. Translated from the Italian by Ernst Freund ... 671
Localized Osteitis Fibrosa in the New-Born and Congenital Pseudarthrosis. Edward L. Compere ... 513
Locking of the Hip Joint Due to Osteochondroma of the Lesser Trochanter. David Poverman ... 1080
Lord Nuffield Central Fund ... 539
[Low-Back Disabilities.] Sacrarthrogenetic Telalgia. I. A Study of Referred Pain. Horace C. Pitkin and Homer C. Pheasant ... 111
[Low-Back Disabilities.] Sacrarthrogenetic Telalgia. II. A Study of Sacral Mobility. Horace C. Pitkin and Homer C. Pheasant ... 365
[Low-Back Disabilities.] Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis. Horace C. Pitkin and Homer C. Pheasant ... 706
[Low-Back Disabilities.] Sacrarthrogenetic Telalgia. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis. Horace C. Pitkin ... 1008
Low-Back Disabilities and Sciatica, The Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of. Frank R. Ober ... 105
Low-Back Pain, Lumbosacral Fusion for the Relief of. A Report of Thirty-Five Cases. Harold G. Lee ... 375
Lumbar Sympathectomy, The Effect of, upon the Growth of Legs Paralyzed by Anterior Poliomyelitis. R. I. Harris and J. L. McDonald ... 35
Lumbar Sympathetic Ganglionectomy, The Effect of, on Longitudinal Bone Growth as Determined by the Teleoroentgenographic Method. John J. Fahey 1042
Lumbar Vertebra, Fourth, Benign Giant-Cell Tumor of the. A Case Report. George A. Duncan and Albert B. Ferguson ... 769
Lumbosacral and Sacro-Iliac Joints, The Knee-Flexion Test for Pathology in the. I. William Nachlas ... 724
Lumbosacral Fusion for the Relief of Low-Back Pain. A Report of Thirty-Five Cases. Harold G. Lee ... 375

M

Maggots, The Therapeutic Active Principle of, with a Description of Its Clinical Application in 567 Cases. S. K. Livingston ... 751

PAGE

Malignancy, Chronic Osteomyelitis Associated with. Melvin S Henderson and Howard A. Swart ... 56
Malignant Bone Tumors, Interesting. Otho C. Hudson, Nathaniel H. Robin, and Percival A. Robin ... 215
Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana, Treatment of, by Means of Acetabuloplasty. M. N. Smith-Petersen ... 869
Malunited Fractures about the Ankle Joint, Operative Reconstruction of. J. S. Speed and H. B. Boyd ... 270
Manipulation and Osteoclasis for Anterior Distortion, Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. ... 1018
[Massachusetts General Hospital Fracture Clinic, End-Result Study.] A Method for Measuring and Recording Joint Function. Edwin F. Cave and Sumner M. Roberts ... 455
Max Böhm ... 1087
Melorheostosis Léri. A Case Report. Richard B. Dillehunt and Eldon G. Chuinard ... 991
[Membrane.] Tunica Vaginalis in Arthroplasty of Small Joints. Clifford Lee Wilmoth ... 165
Meniscus, Bilateral Giant. Maurice H. Herzmark ... 1082
[Meniscus.] The Function of Semilunar Cartilages. Don King ... 1069
[Meniscus.] The Healing of Semilunar Cartilages. Don King ... 333
Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland ... 957
Metabolism, Bone: Its Principles and Its Relations to Orthopaedic Surgery. A. Bruce Gill and Irvin Stein ... 941
[Metacarpal, First.] An Instrument to Aid in the Reduction of Bennett Fractures. Otho C. Hudson ... 1085
Method of Anchoring Kirschner Wires, A. Edward N. Reed ... 532
Method of Blind Pegging Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation, A. Wilbur J. Cox ... 134
Method of Dealing with Chronic Osteomyelitis by Saucerization Followed by Skin-Grafting, A. Basil Armstrong and T. Francis Jarman ... 387
Method of Immobilizing the Chest, A. Adolph M. Brown ... 787
Method for Measuring and Recording Joint Function, A. Edwin F. Cave and Sumner M. Roberts ... 455
Midtarsal Dislocation, Anterior, Report of a Case of. Intratarsal Dislocation. Henry H. Ritter and Walter D. Ludlum, Jr. ... 773
Modification of the Balkan Frame, A. H. O. Foucar ... 526
"Mound Builders" of Eastern Arkansas, The Probable Adaptation of Utilitarian Implements for Surgical Procedures by the. Elmer G. Wakefield and Samuel C. Dellinger ... 434
Muscle Function Recorded by the Electrobasograph, Gait and. R. Plato Schwartz, Otto Trautmann, and Arthur L. Heath ... 445
[Muscle Imbalance.] Further Studies of Fixed Paralytic Pelvic Obliquity. Leo Mayer ... 87
Muscles, Anterior Thigh, Stabilization of the Hip by the Transplantation of the. Lewis Clark Wagner and Peter Cyrus Rizzo ... 180
[Muscles, Paralyzed.] Panastragaloid Arthrodesis. A Study of End Results in Eighty-Five Cases. W. R. Hamsa ... 732
Muscles, Reduction by Tension on the Superficial Flexor Group of. Fracture-Dislocation of the Elbow with Ulnar-Nerve Involvement. Adolph A. Schmier ... 1030

N

Nail, Smith-Petersen, or a Bone Graft as a Means of Internal Fixation, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a. Wilbur J. Cox 134
National Tuberculosis Association ... 539
New Operative Procedure for Instability of the Knee, A. H. Page Mauck ... 984
New Plaster-of-Paris Cutter, A. Joseph K. Narat ... 793
New Use for the Knickerbocker Tongs, A. Correction of Diastasis after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type). Edward Raymond Easton ... 979
News Notes ... 249, 537, 802, 1087
Non-Union of Fractures, Some Thoughts on the Probable Causes of. Henry Turner ... 581

PAGE

Non-Union, or Late Fracture, Use of the Tibial Bone Graft as a Factor in Preventing Delayed Union. Indications for and against the Leg-Lengthening Operation. Edward L. Compere 692

O

Obituaries
Max Böhm 1087
Samuel R. Cunningham 1086
Ernest Muirhead Little 249, 534
John Ridlon 799
William J. Taylor 536
Brainerd Hunt Whitbeck 535
Obliquity, Fixed Paralytic Pelvic, Further Studies of. Leo Mayer 87
Occurrence of Abscesses from Tuberculous Hips That Are Firmly Ankylosed, The. Z. B. Adams 974
Old Dislocations of the Shoulder. George E. Bennett 594
Old Traumatic Displacement of the Distal Femoral Epiphysis. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal 199
Open Reduction, Successful, Followed by Epiphyseal Arrest of the Normal Femur. Old Traumatic Displacement of the Distal Femoral Epiphysis. Daniel H. Levinthal 199
Operative Reconstruction of Malunited Fractures about the Ankle Joint. J. S. Speed and H. B. Boyd 270
Os Calcis, Fractures of the. Richard O. Schofield 566
Os Coracosternale Vestigiale. Congenital Anomaly of the Coracoid. Jerome G. Finder 148
Osteitis Condensans Ilii. Richard A. Rendich and A. V. Shapiro 899
[Osteitis Deformans.] Fractures in Paget's Disease. Mark H. Rogers and Robert Ulin 914
Osteitis Fibrosa, Localized, in the New-Born and Congenital Pseudarthrosis. Edward L. Compere 513
Osteocamp for Osteotomoclasis. David M. Bosworth 648
Osteochondritis of the Capital Femoral Epiphysis, Metabolic Studies in. Lyman A. Cavanaugh, E. Kost Shelton, and Ross Sutherland 957
Osteochondritis Dissecans of the Patella. A Case Report. Charles Rombold 230
Osteochondroma of the Lesser Trochanter, Locking of the Hip Joint Due to. David Poverman 1080
Osteoclasis for Anterior Distortion, Analysis of Results of Early Treatment of Congenital Dislocation of the Hip by Manipulation and. Arthur Krida, Paul C. Colonna, and Francis J. Carr, Jr. 1018
Osteomyelitis, Acute Hematogenous, of the Scapula (Acromion Process). Robert D. Fairchild 232
Osteomyelitis, Acute, of the Scapula (Acromion Process). W. E. Brogden 795
Osteomyelitis, Chronic, Associated with Malignancy. Melvin S. Henderson and Howard A. Swart 56
Osteomyelitis, Chronic, A Method of Dealing with, by Saucerization Followed by Skin-Grafting. Basil Armstrong and T. Francis Jarman 387
[Osteomyelitis, Chronic.] The Therapeutic Active Principle of Maggots with a Description of Its Clinical Application in 567 Cases. S. K. Livingston 751
Osteomyelitis, Colon-Bacillus. Morris B. Cooperman and Gottlieb S. Leventhal 242
Osteomyelitis of the Femur, Fractures Occurring after Operation for, with Ultimate Union. Charles H. Frantz 969
Osteomyelitis, Hematogenous Acute, in Children. John C. Wilson and Francis M. McKeever 328
Osteomyelitis, Pyogenic, of the Spine. An Analysis and Discussion of 102 Cases. Jacob Kulowski 343
Osteosynthesis in Spinal Tuberculosis. Jacques Calvé and Marcel Galland. Translated from the French by Alan H. Todd 46
Osteotomoclasis, Osteocamp for. David M. Bosworth 648
Osteotomy, Subtrochanteric, and Intra-Articular Arthrodesis of the Hip Joint, Some Considerations on. Ernst Freund 654

P

Paget's Disease, Fractures in. Mark H. Rogers and Robert Ulin 914
Pain, Back, Disturbances in and about the Intervertebral Foramen Causing. Apophyseal Subluxation. Lee A. Hadley 428

PAGE

Pain, Low-Back, Lumbosacral Fusion for the Relief of. A Report of Thirty-Five Cases. Harold G. Lee ... 375
Pain, Referred, I. A Study of. Sacrarthrogenetic Telalgia. Horace C. Pitkin and Homer C. Pheasant ... 111
Panastragaloid Arthrodesis. A Study of End Results in Eighty-Five Cases. W. R. Hamsa ... 732
[Paralytic Deformities.] Panastragaloid Arthrodesis. A Study of End Results in Eighty-Five Cases. W. R. Hamsa ... 732
Paralytic Pelvic Obliquity, Fixed, Further Studies of. Leo Mayer ... 87
Parham Band, A Guide for the. S. K. Livingston ... 228
Patella, Osteochondritis Dissecans of the. A Case Report. Charles Rombold ... 230
Pathological Dislocation of the Hip in Children, Stabilization of. J. B. L'Episcopo 737
Pathological Dislocation of the Sacro-Iliac Joint. J. B. L'Episcopo ... 524
Pathology and Treatment of Tennis Elbow, The. J. H. Cyriax ... 921
Pegging, Blind, Fractures of the Neck of the Femur, Using a Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation, A Method of. Wilbur J. Cox 134
Pelvic Abscesses Associated with Acute Purulent Infection of the Hip Joint. Joseph A. Freiberg and Robert Perlman ... 417
Pelvic-Band Leg Brace with Two-Way Motion at the Hip, A. Edwin F. Patton 794
Pelvic Obliquity, Fixed Paralytic, Further Studies of. Leo Mayer ... 87
Pes Calcaneus, Surgical Management of. O. L. Miller ... 169
Phalanges, Proximal, Fractures of the. Alignment and Immobilization. S. A. Jahss ... 726
Phosphatase Activity of the Callus of Adult Bone, The Influence of Roentgen Irradiation on the Rate of Healing of Fractures and the. Eugene M. Regen and Walter E. Wilkins ... 69
Physical Therapy, The Rôle of, in Orthopaedic Surgery. The President's Address. [American Orthopaedic Association.] Frederick J. Gaenslen ... 559
Plaster-of-Paris Bandages, Closed, The Treatment of Surgical Tuberculosis by Vaselin Injections and. Vladimír Jeřábek ... 851
Plaster-of-Paris Cutter, A New. Joseph K. Narat ... 793
Poliomyelitis, Anterior, The Effect of Lumbar Sympathectomy upon the Growth of Legs Paralyzed by. R. I. Harris and J. L. McDonald ... 35
[Poliomyelitis.] An Inexpensive Portable Therapeutic Pool. Philip Palew ... 247
Pool, An Inexpensive Portable Therapeutic. Philip Palew ... 247
Posterior Dislocation of the Hip with Fracture of the Acetabulum. Willis C. Campbell ... 842
[Pott's Disease.] Osteosynthesis in Spinal Tuberculosis. Jacques Calvé and Marcel Galland. Translated from the French by Alan H. Todd ... 46
Presidential Address. [American Academy of Orthopaedic Surgeons.] Frank D. Dickson ... 263
President's Address, The. [American Orthopaedic Association.] The Rôle of Physical Therapy in Orthopaedic Surgery. Frederick J. Gaenslen ... 559
Prevention of Deformity in Arthritis. Loring T. Swaim ... 80
Principle, The Therapeutic Active, of Maggots with a Description of Its Clinical Application in 567 Cases. S. K. Livingston ... 751
Probable Adaptation of Utilitarian Implements for Surgical Procedures by the "Mound Builders" of Eastern Arkansas, The. Elmer G. Wakefield and Samuel C. Dellinger ... 434
Process, Supracondylar, of the Humerus, Fractures of the. Clarmont Paul Doane 757
Prognosis and Treatment of Tuberculosis of the Bones of the Foot. Leo J. Miltner and H. C. Fang ... 287
Prostate Gland, The Relation of the, to Orthopaedic Problems. Wallace S. Duncan ... 101
Pseudarthrosis, Congenital, Localized Osteitis Fibrosa in the New-Born and. Edward L. Compere ... 513
Pseudarthrosis of Tuberculous Origin in Children, Treatment of Quiescent Tumor Albus and. A. Delahaye. Translated from the French by Alan H. Todd ... 51
[Pyarthrosis.] Pelvic Abscesses Associated with Acute Purulent Infection of the Hip Joint. Joseph A. Freiberg and Robert Perlman ... 417
[Pyarthrosis.] Study of the End Results in 113 Cases of Septic Hips. Carl E. Badgley, Luis Yglesias, W. S. Perham, and C. H. Snyder ... 1047
Pyogenic Osteomyelitis of the Spine. An Analysis and Discussion of 102 Cases. Jacob Kulowski ... 343

R

[Recklinghausen's Disease.] Localized Osteitis Fibrosa in the New-Born and Congenital Pseudarthrosis. Edward L. Compere ... 513

PAGE

Reconstruction of the Digital-Tendon Sheath. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons. Leo Mayer and Nicholas Ransohoff . . . 607
Reconstruction, Operative, of Malunited Fractures about the Ankle Joint. J. S. Speed and H. B. Boyd . . . 270
Recurrent Dislocation, Bilateral, of the Ulna at the Elbow. Henry Milch . . . 777
Reduction of Bennett Fractures, An Instrument to Aid in the. Otho C. Hudson 1085
Reduction, Successful Open, Followed by Epiphyseal Arrest of the Normal Femur. Old Traumatic Displacement of the Distal Femoral Epiphysis. Daniel H. Levinthal . . . 199
Reduction by Tension on the Superficial Flexor Group of Muscles. Fracture-Dislocation of the Elbow with Ulnar-Nerve Involvement. Adolph A. Schmier . . 1030
Relation of the Prostate Gland to Orthopaedic Problems, The. Wallace S. Duncan 101
Réunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux . . . 538
Review of 100 Cases of Scoliosis Treated by Spine Fusion. W. E. Brogden . . . 1027
[Rheumatism.] Ligue Internationale contre le Rhumatisme . . . 1088
Rheumatoid Arthritis, Chronic, Streptococcic Dissociation in the Pathogenesis of. L. G. Hadjopoulos and Reginald Burbank . . . 19
Rheumatoid Arthritis, Roentgenographic Features of. Albert B. Ferguson . . . 297
Ridlon, John . . . 799
Robert Jones Lecture . . . 538
Roentgen Irradiation, The Influence of, on the Rate of Healing of Fractures and the Phosphatase Activity of the Callus of Adult Bone. Eugene M. Regen and Walter E. Wilkins . . . 69
Roentgenographic Features of Rheumatoid Arthritis. Albert B. Ferguson . . . 297
Roentgen-Ray Therapy of Bone Tumors. Henry W. Meyerding . . . 617
Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of Low-Back Disabilities and Sciatica, The. Frank R. Ober . . . 105
Rôle of Physical Therapy in Orthopaedic Surgery, The. The President's Address. [American Orthopaedic Association.] Frederick J. Gaenslen . . . 559
Ruptured Crucial Ligaments, Use of Fascia Lata to Stabilize the Knee in Cases of. David M. Bosworth and Boardman M. Bosworth . . . 178
Russell Traction, A Modification of. A Form of Balanced Traction. A. Marians 234

S

Sacral Mobility, II. A Study of. Sacrarthrogenetic Telalgia. Horace C. Pitkin and Homer C. Pheasant . . . 365
Sacrarthrogenetic Telalgia. I. A Study of Referred Pain. Horace C. Pitkin and Homer C. Pheasant . . . 111
Sacrarthrogenetic Telalgia. II. A Study of Sacral Mobility. Horace C. Pitkin and Homer C. Pheasant . . . 365
Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis. Horace C. Pitkin and Homer C. Pheasant . . . 706
Sacrarthrogenetic Telalgia. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis. Horace C. Pitkin . . . 1008
Sacrocoxalgia, Surgical Treatment of. Louis Allard . . . 54
Sacro-Iliac Joint, Pathological Dislocation of the. J. B. L'Episcopo . . . 524
Sacro-Iliac Joints, The Knee-Flexion Test for Pathology in the Lumbosacral and. I. William Nachlas . . . 724
Samuel R. Cunningham . . . 1086
Sarcoma of the Neck of the Femur, Amputation for, by the Interinnomino-Abdominal Method. R. R. Fitzgerald . . . 402
Saucerization Followed by Skin-Grafting, A Method of Dealing with Chronic Osteomyelitis by. Basil Armstrong and T. Francis Jarman . . . 387
Scapula (Acromion Process), Acute Hematogenous Osteomyelitis of the. Robert D. Fairchild . . . 232
Scapula (Acromion Process), Acute Osteomyelitis of the. W. E. Brogden . . . 795
Sciatica, The Rôle of the Iliotibial Band and Fascia Lata as a Factor in the Causation of Low-Back Disabilities and. Frank R. Ober . . . 105
[Scleroderma.] Melorheostosis Léri. A Case Report. Richard B. Dillehunt and Eldon G. Chuinard . . . 991
Scoliosis, Alternating, III. A Study of. Sacrarthrogenetic Telalgia. Horace C. Pitkin and Homer C. Pheasant . . . 706
Scoliosis: Its Prognosis. Joseph C. Risser and Albert B. Ferguson . . . 667
Scoliosis, Sacrarthrogenetic, IV. Differential Diagnosis in. Sacrarthrogenetic Telalgia. Horace C. Pitkin . . . 1008
Scoliosis, A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of. Turnbuckle Brace. Joseph S. Barr and Karl Buschenfeldt 760

PAGE

Scoliosis Treated by Spine Fusion, Review of 100 Cases of. W. E. Brogden 1027
[Screw, Carrell-Girard.] End Results in 100 Fractures Treated by Internal Removable Fixation. W. B. Carrell 408
Selection of the Anaesthetic in Cases of Fracture of the Jaw, The. H. H. Weisengreen 1005
[Semilunar Cartilage.] Bilateral Giant Meniscus. Maurice H. Herzmark 1082
Semilunar Cartilages, The Function of. Don King 1069
Semilunar Cartilages, The Healing of. Don King 333
Septic Hips, Study of the End Results in 113 Cases of. Carl E. Badgley, Luis Yglesias, W. S. Perham, and C. H. Snyder 1047
Sesamoid Bone, Medial, of the Great Toe, Congenital Absence of the. Report of Two Cases. George A. L. Inge 188
Sheath, Digital-Tendon, Reconstruction of the. A Contribution to the Physiological Method of Repair of Damaged Finger Tendons. Leo Mayer and Nicholas Ransohoff 607
[Shoulder.] Acute Hematogenous Osteomyelitis of the Scapula (Acromion Process). Robert D. Fairchild 232
[Shoulder.] Acute Osteomyelitis of the Scapula (Acromion Process). W. E. Brogden 795
[Shoulder.] End Results of Fractures of the Proximal Humeral Epiphysis. Alexander P. Aitken 1036
Shoulder, Fractures and Dislocations about the. Robert V. Funsten and Prentice Kinser 191
Shoulder, Old Dislocations of the. George E. Bennett 594
Shoulder Lesion, An Unusual. David M. Bosworth 1078
Shoulder Strap, Adjustable, for Postoperative Torticollis Cast. Fremont A. Chandler 236
Simple Adhesive Boot for the Prevention of Foot-Drop in Traction-Suspension Procedures, A. H. Davis Chipps 788
Simple Method for the Ambulatory Correction of Flexion Contracture of the Knee, A. The Use of Continuous Elastic Tension as the Corrective Force. Sidney S. Gaynor 766
Skin-Grafting, A Method of Dealing with Chronic Osteomyelitis by Saucerization Followed by. Basil Armstrong and T. Francis Jarman 387
Skull, Epidermoid Cyst in Bone of. J. Harold Couch 475
Sleeve, A Traction. Robert T. Findlay 796
Slipped Upper Femoral Epiphysis, Old, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana, Treatment of Malum Coxae Senilis, by Means of Acetabuloplasty. M. N. Smith-Petersen 869
Smith-Petersen Nail or a Bone Graft as a Means of Internal Fixation, A Method of Blind Pegging Fractures of the Neck of the Femur, Using a. Wilbur J. Cox 134
Sociedad Argentina de Cirugía Ortopédica 805
Sociedad Española de Cirugía Orthopédica y Traumatología 804
Sociedade Brasileira de Orthopedia e Traumatologia 806
Société Française d'Orthopédie 805
Some Considerations on Subtrochanteric Osteotomy and Intra-Articular Arthrodesis of the Hip Joint. Ernst Freund 654
Some Orthopaedic Findings in Ninety-Eight Cases of Hemophilia. Henry Bascom Thomas 140
Some Thoughts on the Probable Causes of Non-Union of Fractures. Henry Turner 581
Spanish Society of Orthopaedic and Traumatic Surgery 804
Spinal Cord, Compression of the, or of Its Roots, Localized Hypertrophic Changes in the Cervical Spine with. S. A. Morton 893
Spinal Tuberculosis, Osteosynthesis in. Jacques Calvé and Marcel Galland. Translated from the French by Alan H. Todd 46
[Spine.] Benign Giant-Cell Tumor of the Fourth Lumbar Vertebra. George A. Duncan and Albert B. Ferguson 769
Spine, Cervical, Localized Hypertrophic Changes in the, with Compression of the Spinal Cord or of Its Roots. S. A. Morton 893
[Spine.] Lumbosacral Fusion for the Relief of Low-Back Pain. A Report of Thirty-Five Cases. Harold G. Lee 375
Spine, Pyogenic Osteomyelitis of the. An Analysis and Discussion of 102 Cases. Jacob Kulowski 343
[Spine.] Sacrarthrogenetic Telalgia. III. A Study of Alternating Scoliosis. Horace C. Pitkin and Homer C. Pheasant 706
[Spine.] Sacrarthrogenetic Telalgia. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis. Horace C. Pitkin 1008
[Spine.] Scoliosis: Its Prognosis. Joseph C. Risser and Albert B. Ferguson 667

PAGE

Spine, Study of Fusion of the, with Particular Reference to Articular Facets. S. L. Haas . . . 717

[Spine.] Turnbuckle Brace. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. Joseph S. Barr and Karl Buschenfeldt . . . 760

Spine, Unusual Fractures of the. Merrill Coleman Mensor and Leon O. Parker . . 153

Spine Fusion, Review of 100 Cases of Scoliosis Treated by. W. E. Brogden 1027

Stabilization of the Hip by the Transplantation of the Anterior Thigh Muscles. Lewis Clark Wagner and Peter Cyrus Rizzo . . . 180

[Stabilization of the Knee.] Use of Fascia Lata to Stabilize the Knee in Cases of Ruptured Crucial Ligaments. David M. Bosworth and Boardman M. Bosworth . . . 178

Stabilization of Pathological Dislocation of the Hip in Children. J. B. L'Episcopo 737

Strap, Adjustable Shoulder, for Postoperative Torticollis Cast. Fremont A. Chandler . . . 239

Streptococcic Dissociation in the Pathogenesis of Chronic Rheumatoid Arthritis. L. G. Hadjopoulos and Reginald Burbank . . . 19

Study of the End Results in 113 Cases of Septic Hips. Carl E. Badgley, Luis Yglesias, W. S. Perham, and C. H. Snyder . . . 1047

Study of Fusion of the Spine with Particular Reference to Articular Facets. S. L. Haas . . . 717

Stump, Gout: An Unusual Manifestation in a. W. E. Kendall, H. C. Fortner, and S. K. Livingston . . . 240

Subluxation, Apophyseal. Disturbances in and about the Intervertebral Foramen Causing Back Pain. Lee A. Hadley . . . 428

Subluxation of the Tibial Head, An Apparatus for Correction of. Jay L. Hutchison 510

Subtrochanteric Osteotomy and Intra-Articular Arthrodesis of the Hip Joint, Some Considerations on. Ernst Freund . . . 654

Supracondylar Process of the Humerus, Fractures of the. Clarmont Paul Doane 757

Supratrochanteric Calcification. Raphael R. Goldenberg and Gottlieb S. Leventhal 205

Surgical Management of Pes Calcaneus. O. L. Miller . . . 169

Surgical Procedures by the "Mound Builders" of Eastern Arkansas, The Probable Adaptation of Utilitarian Implements for. Elmer G. Wakefield and Samuel C. Dellinger . . . 434

Surgical Treatment of Sacrocoxalgia. Louis Allard . . . 54

Surgical Tuberculosis, The Treatment of, by Vaselin Injections and Closed Plaster-of-Paris Bandages. Vladimír Jeřábek . . . 851

Sympathectomy, Lumbar, The Effect of, upon the Growth of Legs Paralyzed by Anterior Poliomyelitis. R. I. Harris and J. L. McDonald . . . 35

Sympathetic Ganglionectomy, Lumbar, The Effect of, on Longitudinal Bone Growth as Determined by the Teleoroentgenographic Method. John J. Fahey 1042

T

[Tank, Waterproof Canvas.] An Inexpensive Therapeutic Pool. Philip Palew . . 247

Tautening Bolt for Use with Kirschner Wire When Plaster-of-Paris Casts Are Used in the Treatment of Fractures, A. J. E. M. Thomson and C. Fred Ferciot . . 245

Taylor, William J. . . . 536

Teaching Problem, Arthritis as a. Robert W. Johnson, Jr. . . . 865

Telalgia, Sacrarthrogenetic. I. A Study of Referred Pain. Horace C. Pitkin and Homer C. Pheasant . . . 111

Telalgia, Sacrarthrogenetic. II. A Study of Sacral Mobility. Horace C. Pitkin and Homer C. Pheasant . . . 365

Telalgia, Sacrarthrogenetic. III. A Study of Alternating Scoliosis. Horace C. Pitkin and Homer C. Pheasant . . . 706

Telalgia, Sacrarthrogenetic. IV. Differential Diagnosis in Sacrarthrogenetic Scoliosis. Horace C. Pitkin . . . 1008

Teleoroentgenographic Method, The Effect of Lumbar Sympathetic Ganglionectomy on Longitudinal Bone Growth as Determined by the. John J. Fahey 1042

Tendons, Finger, A Contribution to the Physiological Method of Repair of Damaged. Reconstruction of the Digital-Tendon Sheath. Leo Mayer and Nicholas Ransohoff . . . 607

Tennis Elbow, The Pathology and Treatment of. J. H. Cyriax . . . 921

Tension, Continuous Elastic, The Use of, as the Corrective Force. A Simple Method for the Ambulatory Correction of Flexion Contracture of the Knee. Sidney S. Gaynor . . . 766

Tension on the Superficial Flexor Group of Muscles, Reduction by. Fracture-Dislocation of the Elbow with Ulnar-Nerve Involvement. Adolph A. Schmier . . . 1030

PAGE

Test, The Knee-Flexion, for Pathology in the Lumbosacral and Sacro-Iliac Joints. I. William Nachlas . . . 724
Therapeutic Active Principle of Maggots with a Description of Its Clinical Application in 567 Cases, The. S. K. Livingston . . . 751
Thigh Muscles, Anterior, Stabilization of the Hip by the Transplantation of the. Lewis Clark Wagner and Peter Cyrus Rizzo . . . 180
Thomas Ring Brace, A Substitute for the. The Ischial Seat Brace. Walter I. Galland . . . 790
Three-Point Hyperextension Back Brace, A. R. A. Griswold . . . 784
Tibial Bone Graft, Use of the, as a Factor in Preventing Delayed Union, Non-Union, or Late Fracture. Indications for and against the Leg-Lengthening Operation. Edward L. Compere . . . 692
Tibial Condyle, Lateral, Cortical Avulsion Fracture of the. Henry Milch . . . 159
Tibial Epiphysis, Fractured Distal, The End Results of the. Alexander P. Aitken 685
Tibial Head, An Apparatus for Correction of Subluxation of the. Jay L. Hutchison . . . 510
Toe, Great, Congenital Absence of the Medial Sesamoid Bone of the. Report of Two Cases. George A. L. Inge . . . 188
Tongs, Knickerbocker, A New Use for the. Correction of Diastasis after Reduction of Rare Ankle Fracture (Maisonneuve-Cotton Type). Edward Raymond Easton . . . 979
Torticollis. S. A. Jahss . . . 1065
Torticollis Cast, Postoperative, Adjustable Shoulder Strap for. Fremont A. Chandler . . . 239
Total Dislocation of the Astragalus. Joseph I. Mitchell . . . 212
Traction, Balanced, A Form of. A Modification of Russell Traction. A. Marians 234
[Traction, Elastic.] The Treatment of Club Feet. Lloyd T. Brown . . . 173
Traction in Four Directions, Dislocation of the Elbow Reduced by Means of. Edward H. Crosby . . . 1077
Traction, Russell, A Modification of. A Form of Balanced Traction. A. Marians 234
Traction, Treatment of Intercondylar Fractures of the Elbow by Means of. Rudolph S. Reich . . . 997
Traction Sleeve, A. Robert T. Findlay . . . 796
Traction-Suspension Procedures, A Simple Adhesive Boot for the Prevention of Foot-Drop in. H. Davis Chipps . . . 788
Transplantation of the Anterior Thigh Muscles, Stabilization of the Hip by the. Lewis Clark Wagner and Peter Cyrus Rizzo . . . 180
Transplanted Cow's Horn, The Fate of. John A. Siegling and John J. Fahey . . . 439
Transverse Bone Atrophy, Acute. Walter G. Stern . . . 659
Traumatic Displacement, Old, of the Distal Femoral Epiphysis. Successful Open Reduction Followed by Epiphyseal Arrest of the Normal Femur. Daniel H. Levinthal . . . 199
Treatment of Benign Giant-Cell Tumors. Henry W. Meyerding . . . 823
Treatment of Club Feet, The. Lloyd T. Brown . . . 173
Treatment of Intercondylar Fractures of the Elbow by Means of Traction. Rudolph S. Reich . . . 997
Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty. M. N. Smith-Petersen . . . 869
Treatment of Quiescent Tumor Albus and Pseudarthrosis of Tuberculous Origin in Children. A. Delahaye. Translated from the French by Alan H. Todd . . . 51
Treatment of Surgical Tuberculosis by Vaselin Injections and Closed Plaster-of-Paris Bandages, The. Vladimír Ježábek . . . 851
Trochanter, Lesser, Locking of the Hip Joint Due to Osteochondroma of the. David Poverman . . . 1080
[Trochanter.] Some Considerations on Subtrochanteric Osteotomy and Intra-Articular Arthrodesis of the Hip Joint. Ernst Freund . . . 654
[Trochanter.] Supratrochanteric Calcification. Raphael R. Goldenberg and Gottlieb S. Leventhal . . . 205
[Tuberculosis.] Arthrodesis of the Hip for Coxalgia in Children. André Richard. Translated from the French by Alan H. Todd . . . 49
Tuberculosis of the Bones of the Foot, Prognosis and Treatment of. Leo J. Miltner and H. C. Fang . . . 287
Tuberculosis, Spinal, Osteosynthesis in. Jacques Calvé and Marcel Galland. Translated from the French by Alan H. Todd . . . 46
[Tuberculosis.] Surgical Treatment of Sacrocoxalgia. Louis Allard . . . 54
Tuberculosis, Surgical, The Treatment of, by Vaselin Injections and Closed Plaster-of-Paris Bandages. Vladimír Ježábek . . . 851

PAGE

[Tuberculosis.] Treatment of Quiescent Tumor Albus and Pseudarthrosis of Tuberculous Origin in Children. A. Delahaye. Translated from the French by Alan H. Todd 51
Tuberculous Hips That Are Firmly Ankylosed, The Occurrence of Abscesses from. Z. B. Adams 974
Tuberculous Joints, Frozen-Section Diagnosis of. Walker E. Swift 641
Tumor, Benign Giant-Cell, of the Fourth Lumbar Vertebra. A Case Report. George A. Duncan and Albert B. Ferguson 769
Tumor Albus, Quiescent, Treatment of, and Pseudarthrosis of Tuberculous Origin in Children. A. Delahaye. Translated from the French by Alan H. Todd .. 51
Tumors, Benign Giant-Cell, Treatment of. Henry W. Meyerding 823
Tumors, Bone, Difficulties in the Diagnosis of. R. I. Harris 631
Tumors, Bone, Interesting Malignant. Otho C. Hudson, Nathaniel H. Robin, and Percival A. Robin 215
Tumors, Bone, Roentgen-Ray Therapy of. Henry W. Meyerding 617
Tunica Vaginalis in Arthroplasty of Small Joints. Clifford Lee Wilmoth 165
Turnbuckle Brace. A Three-Point-Pressure Brace for the Corrective Treatment of Ambulatory Cases of Scoliosis. Joseph S. Barr and Karl Buschenfeldt ... 760
Turner, Henry 1087

U

Ukrainian Society of Orthopaedic and Traumatic Surgery 807
Ulna, Bilateral Recurrent Dislocation of the, at the Elbow. Henry Milch 777
Ulnar-Nerve Involvement, Fracture-Dislocation of the Elbow with. Reduction by Tension on the Superficial Flexor Group of Muscles. Adolph A. Schmier ... 1030
Union, Ultimate, Fractures Occurring after Operation for Osteomyelitis of the Femur, with. Charles H. Frantz 969
Ununited Fractures of the Neck of the Femur. T. P. McMurray 319
Unusual Fractures of the Spine. Merrill Coleman Mensor and Leon O. Parker. 153
Unusual Shoulder Lesion, An. David M. Bosworth 1078
Use of Fascia Lata to Stabilize the Knee in Cases of Ruptured Crucial Ligaments. David M. Bosworth and Boardman M. Bosworth 178
Useful Amputation Guard, A. Francis M. Findlay 236

V

Vaselin Injections and Closed Plaster-of-Paris Bandages, The Treatment of Surgical Tuberculosis by. Vladimír Jeřábek 851
Vertebra, Fourth Lumbar, Benign Giant-Cell Tumor of the. A Case Report. George A. Duncan and Albert B. Ferguson 769

W

Whitbeck, Brainerd Hunt 535
William J. Taylor 536
Wire, Kirschner, A Tautening Bolt for Use with, When Plaster-of-Paris Casts Are Used in the Treatment of Fractures. J. E. M. Thomson and C. Fred Ferciot 245
Wires, Kirschner, A Method of Anchoring. Edward N. Reed 532

X

X-Rays, The Effect of Large Doses of, on the Growth of Young Bone. Eugene M. Regen and Walter E. Wilkins 61